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Photograph by Meurisse. Cuirassiers of the French army assisting a wounded comrade.

THE CARE OF THE WOUNDED IN THE PRESENT WAR.—[See page 328.]

Muscular Activity and Thought Processes

Various Psychological Theories Reviewed

By Knight Dunlap, Associate Professor of Psychology in the Johns Hopkins University

THE psychology current to-day is founded on a doctrine of imagination which is so simple and so generally accepted that it seems as assured as the law of gravitation. The *mental image* is supposed to be an actually existing object, although in the "mind," and to be as observable as are the qualities of external objects. In fact, as is well known, there have been many philosophers who have maintained that what we call the "external" world is nothing but the system of mental images of him who observes it. Many more, while rejecting this sweeping theory of "subjective idealism," have insisted that all we directly know or observe is exhausted by the "mental images" and their interrelations, and that therefore our knowledge of the "outer" world is indirect, and is possible only because our "mental images" represent, or in some way correspond to, this outer world. This latter theory ("dualism") has been the source of some trouble to its adherents when they have tried to explain just how we know that our images *do* correspond to the outer realities, since we are unable to observe anything but the images. But the theory has nevertheless been held by the majority of educated men since the sixteenth century, and has with few exceptions been explicitly or tacitly assumed by the professional psychologists of the last forty years.

Psychologists, however, have recognized two classes of these "mental images," and have for the most part applied the name to one class only, calling the other class *sensations*. We shall, therefore, from this point on, take the term "mental images" as restricted in this way. "Sensations" are produced in the "mind" when certain features of the external world (called *stimuli*) act on the nervous system. Thus, ether vibrations of a certain rate impinging on the retina of the eye, excite the minute nerve endings called *cones*, and through them the nerve cells within the brain, and ultimately muscles throughout the body; and the "sensation of red" is produced.

"Images," on the other hand, are produced by the action of the nervous system without the excitation by a stimulus. Thus, when I close my eyes and imagine red, it is assumed that the red in this case is an "image." Just as there is an "image" of red, there may be "images" of blue, of yellow, of sweet, of sour, of musk or of any other quality the senses give. Not all minds, however, possess all types of images to the same extent. Some persons are predominantly "visualizers," and in their mind the visual image occurs very distinctly and freely, whereas auditory images occur less freely and are vague, while images of smell and taste may be practically absent. Other minds are "auditory," and a few may be strongly "olfactory," and so on. A great deal of work has been done in the attempt to devise methods for determining the "type" to which a given person belongs, and a great deal of emphasis has been laid on the importance of making these determinations. This work was started by Francis Galton, and has occupied a prominent place in modern so-called experimental psychology. It will be readily seen that if these type distinctions are important, the knowledge of the type to which a child belongs may determine the method of presentation of material he is required to learn. The "auditory" child may learn more easily what he hears, whereas the "visual" child may learn more readily what he sees.

According to the conventional psychological view the sensations and images, with their interrelations, really make up all we can observe or of which we can be conscious. There has been a long dispute in psychology as to whether the *relation* should be admitted as a specific subject for psychological investigation, but this is a technical matter which has no present interest. We can here confine ourselves to the study of the sensations and images, assuming that the relations are perceived.

When I imagine, or remember, or think, I am attending to *images*. When I perceive, I am attending to sensations and images together: for it soon becomes evident that pure sensations are practically never found. When I perceive, the object of my perception is constituted by a few sensations and many images. The apple on the table before me is not a mere sensation of red, but contains in addition the images of the resistance, coolness, sweetness, tartness, etc., which I have previously experienced. If this were not so, a painted apple and a real apple would be the same for visual perception, whereas they are usually not the same.

The sensation and the image are not without points of similarity. The exact points of difference, in fact, have long been the subject of dispute among psychologists. Many hold that the essential difference is in *intensity:* that the image of a candle flame differs from the sensation of a candle flame, for example, principally in being far less bright. Others hold that the image has *no intensity whatsoever*: that there are no brightness differences in images of light of various brightnesses. One image may *represent* a bright light, and another *represent* a dim light, according to this view, but there can be no difference in the brightness of the images, because neither of them has any brightness at all. Another theory of the difference between image and sensation is that the latter is more vague, less sharply defined than the former.

In recent years several painstaking studies of images have been made, with the hope of deciding these vexing questions. The results have not been all that could be desired; some observers deciding that images have intensity, others that they have not, etc. The studies, however, have shown one thing very clearly: psychologists of all the orthodox schools look on the images as very definite and observable entities, having the same qualities as do sensations, and regarded practically as *copies* or modified reproductions of sensations.

The great difficulty with the doctrine of images has been in making it actually cover what we commonly call *thought*. When I "think of" an ink bottle which is in a room a mile from here, the fact is (according to the orthodox doctrine) that I have at present in my mind an image of that bottle. It is not contended that the image is necessarily a *visual* image of the bottle: an image of the sound of the words "my ink bottle" may serve the purpose. The question is, how do I know this image is the image of that particular bottle? This knowledge is necessary, if the image is to help me think of that bottle as distinguished from others. The answer customarily made is that the image *means* that bottle. *Meaning*, in other words, is brought in *ex machina* to bridge the gap between the image and the bottle a mile away. So if I am thinking of a fire which burned yesterday, *meaning* bridges the gap between the image I have to-day and the fire which existed yesterday.

In effect, therefore, I am conscious of the image, and also conscious in another way of the object to which it refers, and hence know that the image refers to the object. A full explanation, although complicated; but what is the use of the image?

Such discrepancy, together with the reports of certain persons of intelligence who claim they have never had any "images" such as psychologists describe, have kept alive continuous opposition to the orthodox theory of image, and a significant movement in psychology today is toward the rejection of this theory. This movement has been foreshadowed by two other movements, one profound and the other more superficial: the "new realism" in philosophy, and the 'imageless thought" movement in psychology.

The "new realism" began with Prof. James' rejection of the doctrine of the traditional "mind," and has a diversity of expression at the present day. The general movement is a rejection not only of the "mental images" of the psychologist, but of the "sensations" as well. The four-hundred-year-old notion of an "inner world" to which we are limited, and through which we know an "outer world," is given up. What we know are *real objects*. The color, for example, which psychologists have been insisting is a "sensation" in a "mind," is for the new realist a real object, as "external" as anything can be.

Like most profound revolutionary movements, "new realism" goes too far. In addition to denying a world of "mental" objects, the various sorts of "new realists" deny the existence of an ego or knower. The new realistic theories of how knowledge or experience occurs at all are too complicated to be briefly presented, but it is not unfair to say that the various objects in the world are supposed to experience one another.

The other movement to which I have referred, that of "imageless thought," does not reject the orthodox formulation of psychology, but attempts to add to it. Various psychologists who accept images quite faithfully have observed that thought does occur in cases where no "images" can be found. Hence they have added to "sensation" and "image" another category of mental objects, which are variously called by various theorists "Bewusstseinslage," "Wissens," and other terms which will not submit to English translation. This movement, although without any positive issue, is serving to unsettle psychological theory, and is a preface for a more fundamental revision.

Let us now go back and examine the processes of thought and perception. It is evident, even on the theory of images, that one can be conscious of objects and events in two ways. One can be conscious of what is *now here*, and also one can be conscious of what *was* or what *is elsewhere*. In short, one can *perceive* and one can *think:* the two forms of consciousness are *perception* (we might well revert to the term *intuition*) and *thought* (including memory and imagination). These forms of consciousness are fundamental, and no psychology has ever been able to dispense with the distinction between them.

As regards the *things of which we are conscious*, we may continue to call the objects of perception *sensations*, understanding by that term its literal significance of *those things which are perceived through the senses*. But the objects of thought are then sensations also, at least in many cases, and not any mere "copies" of sensation. The difference is not in the *object* of consciousness, but in the fact that in the one case we *perceive* (or intuit) them, and in the other case, *think of them*.

The doctrine of the "image," however, is a crude recognition of the fact that in any process of thought or memory there is not only a content thought of or remembered, but also a concomitant present content perceived. If this were not the case the doctrine of images could never have been so long held, even if it could have arisen. What, then, is the immediate content in thought if there are no "images" of the type conventionally described?

This question is answered definitely by those who have accepted what may be called briefly the "muscular theory of thought." The immediate content of thought is *muscular sensation*. "Sensation" is a multivalent term, as has been pointed out many times by philosophers and psychologists, so that we might as well rephrase this statement by saying that the immediate object in a thought is always a muscular contraction as "felt," i. e., as perceived through the action of sensory nerves running from the muscles themselves. This latter qualification is essential, since the contractions might also be seen or perceived through touch, as when the fingers of one hand are placed upon bicep of the other arm.

If the realities which have been miscalled "images" are all muscular, how is it that the current doctrine of images of various modalities—visual, auditory, gustatory, etc.—has grown up? In order to answer this question we must consider the way in which these muscular "images" arise.

All consciousness, it is now understood, is conditioned by *arc-reflexes*. The arc-reflex is the functional activity of a *reflex-arc*, a chain of neurons (nerve cells and their fibrous extensions) which begins at a "receptor," or sensory termination, (such as the delicate cells in the retina of the eye, which respond to light, or the hair cells in the inner ear which respond to sound vibrations, or the corpuscles in the skin which respond to pressure) and runs into the spinal cord, finally on up to the brain, then down the cord and out again, terminating in an "effector," namely, in a muscle or gland. Any sensory stimulation of sufficient intensity must, therefore, result ultimately in a modification of muscular or glandular activity, or both.

The glandular activity has no direct effect on the nervous system since there are no receptors in glands; but there are receptors (called "muscle spindles") in voluntary muscles, and when these are stimulated, by the contraction of the muscle, new reflexes are started over the arcs beginning in these spindles. These arcs may terminate in other muscles.

Perceptual consciousness and thought consciousness are both conditioned by reflexes over arcs terminating in voluntary muscles. This is a fact which has long been known. We may express it in a slightly different way by saying that muscular activity is a normal part of the essential physiological process which controls cognitive consciousness. This fact is sometimes, but incorrectly, referred to as the "motor power of consciousness." Feeling-consciousness, that is, the experience of pleasure, pain, desire, and similar contents, is probably conditioned by reflexes over arcs which terminate in glands, or in the involuntary muscles found in the stomach, intestines, and certain other parts of the body.

In some cases, the arcs are relatively fixed. In other cases, particularly in the case of arcs terminating in voluntary muscles, the connections of the neurons forming the chains may be varied. Just how the variation in the interconnection of neurons is brought about is not known, but it is made possible by the fact that each neuron in the nerve centers (brain and spinal

cord) is in contact with many other neurons, and can thus discharge into one or another or several of them, as circumstances may determine. Once formed, however, an arc tends to persist; that is, if a certain sensory excitation, or group of excitations, has once resulted in a given set of muscular contractions, there is a tendency for the same excitation on its next occurrence to produce reflexes through the same arcs, and hence to result in the same set of contractions. This is the established *neural habit*. With repetition of the reflex, the habit becomes more strongly established. Thus it is that a given object, frequently exciting the sense organs, comes eventually to have a definite muscular response. This muscular response becomes, therefore, the symbol (or "image") of the object, and since it is the starting point of a new reflex, a series of such muscular contractions becomes, by the action of neural habit, bound together in a mechanical chain, so that in the absence of interfering stimulations, and eventually in spite of such, if one contraction occurs it will be succeeded in an automatic way by the other members of the chain.

This rechaining of reactions is the physiological side of the "association of ideas," for each reflex from voluntary muscle back to voluntary muscle is the condition not only of the perceptual consciousness of the contraction or image which starts it, but also the thought of the object which normally initiates the arc terminating in the contraction. The varying "attention" to the two things, now to the image and now to the thought-object or idea, is a matter of interrelation of the various arcs occurring simultaneously in the nervous system, and is too complicated for consideration here. Attention to the muscular process, usually called the "image," rather than to the external objects, is one form of the process known as *introspection*, which is the observation of images or of feelings.

We may now understand how the images may be misinterpreted, as they have been in the past, and supposed to be of visual, auditory and other kinds. The very fact that the nature of the image and of the process of intropsection has not been understood has entailed impure introspection, the idea or ultimate thought object being confused with the image. Hence, if an idea is strongly visual in its character, it has been easy to neglect the actual image and assume that there is present a visual image or "copy" of the idea. Moreover, visual objects regularly call forth, as part of their reflex results, activity of the eye muscles, these muscles taking part, therefore, in the image of the object, and this in itself conduces to the interpretation of the image as *visual*. The contraction of the small muscles within the ear conduces likewise to the misinterpretation of the auditory object as an auditory image.

The muscles which take part in the furnishing of images include practically the whole of the voluntary system; i. e., the muscles attached to the skeleton, and certain others belonging to the visceral organs. In adult individuals the vocal muscles are, of course, most important, most of our thinking going on in terms of the articulatory movements which produce spoken words. Next in importance are the eye and inner ear muscles and the muscles of the arms and upper trunk. Even those of us who do not, like the Latin races, make the images apparent to others with the aid of our arms, still use these members slightly, thus complicating the images as we perceive them ourselves.

The muscular explanation of the process underlying thought activity is not merely of speculative interest, but is of practical importance to all the psychological sciences. Psychological investigations, like that of biology, have always been influenced by hypotheses, and always will be. In fact, it is doubtful if research in any line could proceed except under the guidance of pertinent hypotheses. There is evidence already that the muscular explanation of thought processes is to have a profound influence in shaping the research in a great many lines, and in supplying means of interpretation and criticism of what has already been accomplished. The problems of habit-formation, including learning in school, are having new light thrown on them, and new possibilities of investigation disclosed. The feelings and emotions, so important from the psychiatrist's point of view, but psychologically chapters in a closed book, are opening up. Even the will—the surd of psychology—becomes a possible subject of experiment in the light of the new doctrine of thought. Hypnosis and the so-called sub-conscious may be taken from the realm of the occult and put on a sound, although prosaic, psycho-physiological basis. Dreams, long material for the mystics, now the exploitabilia of the Freudians or neglected as meaningless jumbles, may be investigated as normal features of conscious life. Whatever may be the final form of the muscular theory, and whatever may be the final verdict upon it, it will inevitably have far-reaching consequences in the future of psychological investigation.

Parenty's Outflow Regulating Devices*

COMMON practises of disposal in this twentieth century of community wastes and factory effluents which not uncommonly find their way into streams, present certain problems since the water courses and lakes are very necessary for the supplies for domestic purposes.

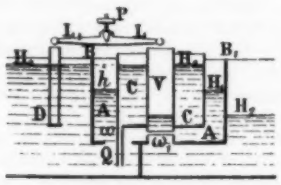


Fig. 1.—Section of regulator.

The absolute need of knowledge with reference to the purification of effluents and streams into which they flow has caused considerable activity in investigation and has been a fruitful field for invention.

Among the most recent of the methods of caring for the flow of effluents or streams receiving them is that presented by M. Parenty in a memoir read before the Academy of Sciences (Paris) on May 11th. He attacks the general problem in a number of ways, one of which is the regulation of a variable outflow. The effect of such regulation, or one phase of it at least, will be to spread the treatment of an intermittent effluent, or one which flows only during working hours, throughout the whole twenty-four hours, and may be applied either where it is desired to make the outflow uniform or where filters of one kind or another are to be employed. Following are the principal suggestions of the memoir.

Fig. 1 is a diagrammatic presentation of the regulator in section. A division wall lies between the receiving basin to the left and the outflow basin, treating tank or filter supply to the right. The two basins have different water-levels, as may be observed. Between these basins and forming a portion of the dividing walls is a chamber or lock, *A*, *A*. This has an inflow of fixed orifice, ω, and an outflow beyond the wall and into the basin, ω_1, which may be regulated.

The regulation of the outflow is effected by means of a flotation box, *C*, *C*, concentric with the valve, *V*, and moving it. The two are suspended from the arm of a balance, *L*, L_1. The flotation box is connected with the inflow reservoir and maintains the water level of the latter, the lock *A* being variable and somewhere between inflow and outflow levels. The submergence of the box, and with it the valve and the amount of outflow, will depend upon the difference in levels between the reservoir and the lock. This difference is so computed that the outflow will be uniform.

The inventor arranges for a correction to account for the different displacement of the box walls at different levels by a counterpoise, *D*, which is varied in the amount of its own submergence. Similarly the different displacements of the valve, *V*, in different positions are cared for by another counterpoise, *P*, above the pivots of the balance.

* Translated from *Le Genie Civil*.

The other figures show some of the details and modifications under different circumstances. In all of them *R* is the storm water outlet to care for sudden flows which might cause derangements of the surfaces of the filtration beds. Fig. 2 is an application by Parenty of his principles to flushing basins and is adapted to small plants. The same general principle is maintained, but the flotation box here serves both for box and regulating valve. The inlet of fixed size, ω, is here in the bottom of the lock, *A*, which in the diagram is relatively much smaller than in Fig. 1, and the outflow is over the wall at *S*. The height of water in the box is the same as in the reservoir, being maintained there by means of the tube *U*, the tube *N* being a connection between the interior and the outer air.

In effluents the weak and intermittent flows are factors unfavorable to uniform distribution over filtering beds. The Parenty method of overcoming the difficulty is shown in Fig. 3. For the distribution over the bed, *I*, there is the familiar system of perforated tubes, *G*, or sprinkling nozzles, *H*, *H*, under pressure. The distributor that is recommended here is a siphon, *S*, which discharges into a movable bucket, *C*, on the arm of a lever and counterbalanced. The position of the bucket with reference to the fixed end of the siphon regulates the amount of flow.

Fig. 4 shows the principle again for outlets of large capacity. Here a metal disk, *L*, counterpoised, plays between the walls of the outlet. It regulates the outflow according to the pressure of the outflow upon it, which again is dependent upon the head of water in the reservoir. The flow may here be gaged by means of the index, as shown. Fig. 5, also for large outlets, presents the combination of this disk with the flotation box, the bottom of which forms the valve.

The figures show various other matters which are discussed in the original memoir. The tubes at the sides of Figs. 2 and 5 are piezometers, and *H* with its differentiating figure represents water levels whose differences form the important factor to the uniform outflow.

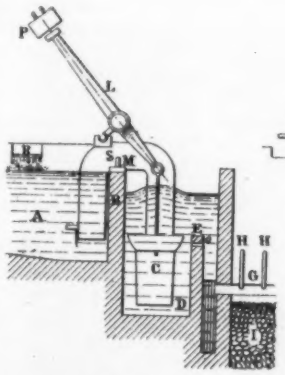


Fig. 3.—Details for small outflow.

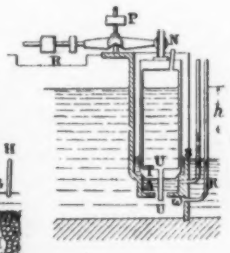
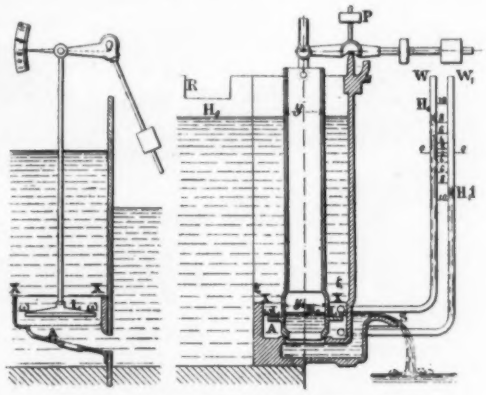


Fig. 2.—Details for small outflow.

For all these various forms Parenty claims that with small differences in level and in places where there is little room to spare, they effect their work with remarkable accuracy. They have recently been installed in the Port Said Nile filtration basins and also in various purification plants on the Calmette system in France, Belgium, Holland, and Indo-China.



Figs. 4 and 5.—Details for large outflow.

Poisoning Tree Scale

A CORRESPONDENT in *Science* relates the following rather startling experiment in killing tree scale by poisoning the sap of the tree. He says:

"I have in my ground a plant of Spanish broom about a dozen years old and with a trunk about four inches in diameter which has for several years been seriously infested by cottony cushion scale (*Icerya purchasi*). I have tried various sprays, have put scale-eating beetles on the tree, and at one time cut all the branches off and sprayed the trunk several times in the attempt to get permanently rid of this scale, but up to last winter it seemed that all attempts were in vain. In February of this year, when the broom was very thickly covered with the scale, I bored a ⅜-inch hole in the trunk to a depth of about three inches, filled the hole nearly full of crystals of potassic cyanide, and plugged it up. In two days the scale began to fall from the tree and in a few days all appeared dead. Others hatched and attacked the tree, but lasted only a short time, and the tree has since been free from scale and very vigorous.

"At the same time I bored a similar hole in an old peach tree which seemed to have passed its usefulness and put a like charge of potassic cyanide in it. The tree has since seemed more vigorous than before, and raised a fair crop of peaches. After feeding some of them to chickens and a rabbit with no apparent ill results, I ate some of the peaches, and could find nothing wrong with them. I have since put a similar charge of the cyanide in an orange tree with no apparent bad effect.

"It would seem from this experiment that it is possible in some kinds of trees, at least, to poison scale and sap-eating insects without injury to the tree. The method would seem to be especially adapted to killing various kinds of borers and insects which, like the pine beetles, burrow beneath the bark."

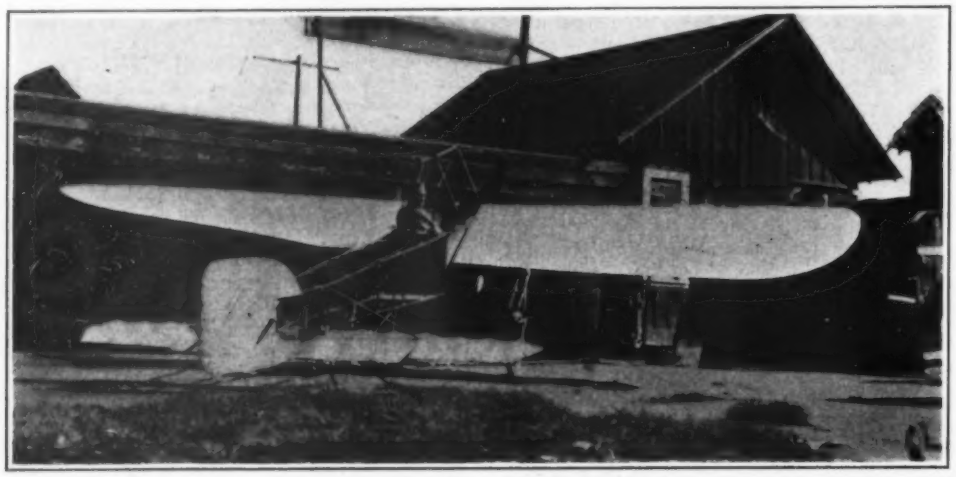
An American Aeroplane with Adjustable Wings

Improvements Necessary to Make Flying Safe, Practical and Commercial

By Carl Dienstbach

A DEVICE by which the incidence of the wings to the line of the propeller thrust and the axis of the fuselage may be varied at will during flight, strongly advocated by a writer in the SCIENTIFIC AMERICAN, and so brilliantly vindicated in France by the aeroplane "Paul Smith," was embodied still earlier in an American monoplane of the Blériot type, built by Ray Louis Matteson in California, and shown in the accompanying illustration.

A worm gear enables the angle of both wings to the fuselage to be changed simultaneously with a minimum of effort on the part of the pilot, and without disturbing the warping or the interaction between the two wings. The worm gear undoubtedly obviates two inherent difficulties of adjustable wings in providing an easy action and, being non-reversible, automatically locking the wings at any desired angle. Emergencies of flying, however, demand very quick action as well, and it must be possible to present the wings to the air at their steepest angle just an instant before touching the ground in landing, and this quite as suddenly as those of a sparrow are tilted in alighting on a twig. The wings must be swung with lightning speed into a position where their drift largely exceeds their lift, and a slow change of their incidence by the hand of the pilot working a worm gear would result in the very opposite effect of sending the machine skyward. It is therefore necessary either to provide a clutch by which the motor may be made to drive the worm gear for an instant at a very high speed, and release it just as quickly, and an automatic band brake to stop just as suddenly any further movement; or the worm gear must be replaced by a piston in a cylinder worked by compressed air from a tank, with suitable valve arrangements to instantly move it in either direction and lock it in any desired position. These mechanisms are so easy to provide that it would be a great pity if, first of all, an entirely novel and extremely useful way of landing like a bird, practically without a subsequent run, could not be soon reduced to practice by an American machine.



The Matteson adjustable wing monoplane.

The next task to be accomplished by an aeroplane with power adjustment of wing incidence would be to learn to practically stop in the air without falling, by shutting off power and "knocking" the wings into their steepest angle and just as suddenly reduce that angle only a little and running the motor at maximum power.

A really efficient execution of this maneuver calls indeed for a propeller whose pitch can be just as suddenly reduced to a maximum "standing pull"; and eventually, even for a variable speed drive between motor and propeller, as in an automobile.

No doubt many designers would be horrified by such "complications." But we see to-day that the path of practical improvement for such a rough-and-ready machine as a motor bicycle does not tend in the direction of simplifying but of so-called complicating, by adding clutch and change speed drive. Ten years ago the automobile was crammed with complications and designers are now busy adding electric starters and adjustable carbureters, etc., to facilitate their operation. In the same manner, adding so-called complications opens the only way of making the primitive aeroplanes of to-day more reliable, more safe, and consequently, at last, more practical and commercial. Nature shows us in flying birds the most efficient, economical, and practical kind of locomotion—only the migrating plover can enjoy the fruits of Alaska. But the flying machinery of birds, with the possibility of an infinite number of adjustments, is a hundred times more complicated than the proposed aeroplane. Nevertheless, just owing to the greater resourcefulness of mechanical arts as compared to inherent limitations in biological development, the proposed aeroplane will share the great privilege of birds over all present flying machines, in that they will not fall when an "airhole" suddenly destroys most of the relative motion between the air and the sustaining part of their advancing wings, or if it suddenly pours over them a wave of descending currents—incidents which aeroplanes are at present vainly trying to fend off by an inertia-forbidden sudden increase of speed. The proposed machine will instantly increase its lift *right on the spot* by a much steeper flying angle.

This of course calls for reserve power in the motor, or rather increased size of an adjustable pitch propeller with "two-speed drive" from the motor, but is no less possible than a bird's sudden increase of lift, right on the spot, by the vigorous flapping of the whole wing. Lilienthal has shown that such flapping is economical in power, and in the case of the bird, similarly reduces the needed extra effort. As for the mechanical devices named for the aeroplane, flapping is necessarily as much the tactics of Nature as the reciprocating lever action of legs and fins in running and swimming, but increasingly difficult to reproduce in a flying machine on any scale larger than a condor. To make stationary wings strong enough for the vicissitudes of flight taxes all mechanical resources, even in a medium-sized aeroplane. The Russian mammoth biplanes will, for good reasons, never attempt the arts of Pegoud.

All indications point to progress in the direction of making the medium and smaller-sized aeroplane as complicated and resourceful as a bird. There is an enlightening comparison to silence any protests against complicating. What must be more solid than a military rifle? Still, what a complicated machine serves now as a handle for the modern soldier's "pike," the bayonet, as compared to the simple tube of a hundred years ago! And this same small rifle has been easily turned into a "machine gun," whereas automatic cannon of larger caliber are difficult to make. Small pistols approached machine guns even with the invention of the first Colt revolver, and have now developed to well-nigh completely automatic action, although they must withstand much knocking about. The lesson for the small aeroplane is obvious. Fokker in Berlin recently constructed a tiny single-seater monoplane for "Pegoud-flights" with wings on which a photograph has shown a complete file of full-grown men standing without causing any distortion, and which has shown such marvelous flying qualities that its designer was officially honored.

Even as practical a flier and engineer as Helmuth Hirth has predicted machines with adjustable wings and reversible propellers in a book on his experiences, with a forecast into the future. Why has no prize been offered for realizing his proposal, instead of straining the present imperfect type to its limit in trying to increase size and radius of action?

Does all technical progress in flying have to depend on sensational tasks? Hirth predicted, also, high speed with small power; in other words, great radius of action for lightly loaded machines, due to refinement in design. If it was found necessary to equip the ocean-flying "America" with a third motor, it does not look as though a prize for crossing the Atlantic would bring about this much desired progress.

The aeroplane closely resembles the bird in limitations, and a sea-going machine should "feed" from the water like a gull or an albatross. In the light of what has been said above, one word suffices in pointing to the possibility of easily resting and raising an "America" on and from troubled waters by enormous adjustable two-drive propellers and adjustable wings; in other words, developing *great air lift at slow speed*. The "America" fell back into the water after the hydroplanes had lifted her.

This would permit safe alighting, restarting, and picking up fuel from steamers. If a very small fraction of the weight saved in fuel were devoted to a powerful searchlight (weights of aerial lights have recently been greatly reduced), making dead reckoning from the water feasible at night; and if, during periods of fog, a modified patent log were dragged behind on a piano wire, with a predetermined breaking point, there would be no difficulty to rendezvous with steamers.

The parallel between the direct lifting-flapping of birds and an aeroplane with a steep angle of attack holds good yet in another very important direction. In the last report of the Advisory Committee for the English government—now the most important contribution to the science publicly available, barring Eiffel's experiments—it was made clear that only with a high angle of attack is the aeroplane safe from insidious air chutes, and that for this reason fast machines are, contrary to theories, always flown slower when pilots encounter treacherous air conditions, just as soaring gulls can be seen to resort to flapping in gusts.

Thus, what is proposed here means only the *enlightened elaboration* of a policy already tried and proven by the best authorities, with this difference, that it was not derived from blind practice only, but from extensive study.

A fast modern machine thus operated, with the sole help of the elevator, becomes a very crude apparatus, ill adapted to its new function. Part of the wing finds itself in a current descending from the propeller. The fuselage is forced broadside on through the air, making its streamline form useless; and, worst of all, the small rudders and flaps, designed for normal speed, lose so much of their grip upon the air that they must be worked constantly near their critical angle, where further increase of effect becomes impossible, and the machine is in imminent danger of getting out of hand.

The small propeller designed for efficiency at high speed wastes as much power in slip as in starting, and the motor, even with throttle wide open, can no more run at maximum speed and power than in starting. Wilbur Wright told the writer as early as 1905, with his mystifying smile: "There is a propeller for everything, and the best propeller for normal flight is not the best propeller for starting." The obvious conclusion is that we need a propeller adjustable for different conditions. And yet, when a master designer like Chauvière exhibited it in large size, none seemed to grasp his purpose.

The proposed two-speed drive needs nothing like the range on an aeroplane that is required in a motorcycle. But when, with a maximum angle of attack for the wings, the greatest reduction of pitch for the enlarged propeller, which may be used without losing efficiency, does not yet allow the motor to run at maximum revolutions, the advisability of shifting gears becomes obvious. There are such simple, elementary, mechanical improvements needed in the present aeroplane that the constant expectations for something very far-fetched seem as pitiful as the wild fancies about the Wright machine while that was yet the famous mystery.

The awarding of one of the two prizes given in the recent safety contest in France to the "Paul Schmidt" was as just as that to its only successful rival who demonstrated so strikingly the beautiful mechanical brain now available for any type of flying machine, but would have been yet more deserved if this mechanical improvement had not needlessly stopped short at adjustable wings, with Chauvière's adjustable propeller, ready to mount.

It must also be kept in mind that all these adjust-

ments must be capable of being operated as quickly as a rudder is now swung to be available in emergencies, and that Blériot's simple "bell" must be developed into something almost as complicated and yet as quick and easy to handle as the stops of an organ.

With this we return to the meritorious American "Blériot" which furnished the occasion for this wide-scoped discussion. If, unlike the "Paul Schmidt," it has no record as yet of convincing tests, this is to be attributed to an error of the designer, who concentrated his efforts more on the attainment of automatic side control by a differential gear, automatically equalizing the pressure on self-adjusting warping wings. This would be possible if equilibrium could afford to neglect the *direction* of such pressures, but differences in direction of nearly 45 degrees may thus balance themselves in an extreme assumed case of a violent gust on the left and lull on the right, and this leads *ad absurdum* the belief that equilibrium could be maintained in this manner.

Pasteur's Words in Mankind's Struggle

In view of the present conflict it may be well to recall Pasteur's words, spoken in 1888. They were as follows: "Two opposing laws seem to me to be now in contest. The one, a law of blood and death, opening out each day new modes of destruction, forces the nations to be always ready for battle. The other, a law of peace, work, and health, whose only aim is to deliver man from the calamities which beset him. The one seeks violent conquests; the other the relief of mankind. The one places a single life above all victories; the other sacrifices hundreds of thousands of lives to the ambition of a single individual. The law of which we (men of science) are the instruments strives, even through the carnage, to cure the wounds due to the law of war. Treatment by our antiseptic methods may preserve the lives of thousands of soldiers. Which of these two laws will prevail, God only knows. But of this we may be sure, that science will obey the law of humaneness, and will always labor to enlarge the frontiers of life."

A Home Made Electric Incubator and Brooder

A Safe, Simple and Efficient Device for the Home Mechanic

By Charles B. Hayward

For the average "back-yard" chicken fancier, whose flock seldom exceeds fifty fowls, an incubator is a superfluity. But at times the hen is exasperatingly fickle and refuses to assume the seclusion of maternal duties just at the time when her services as a hatching machine are most in demand. An experience of this kind extending over two seasons, during which a small though very useful flock steadily diminished in numbers almost to the vanishing point, led to the construction of the incubator described here. There was no alternative but to buy chickens or to hatch them artificially, and as the latter was the more economical it was undertaken. However, the incubator problem was not one to be settled offhand, as the fire underwriters' rules prohibit the use of the lamp-heated type in insured buildings of any kind without special permission, and this permission is difficult to obtain, except for the high-priced machines. Having no desire to hatch chickens *à la* gentleman farmer at two to three dollars apiece, a high-priced incubator was out of the question. Moreover, the best lamp-heated types require more or less constant supervision, which is not desirable for the amateur whose only opportunity to look after such things is at the beginning and end of the day.

As the "attach it to any socket" electrical device does not call for special inspection on the part of the fire underwriters, it was decided to build an electric incubator. Contrary to the general impression, there is nothing mysterious about an incubator. It is merely a heat-proof box with provision for ventilation, heat-supply and the maintenance of the heat at a certain temperature—not lower than 100 deg. F. or higher than 105 deg. F., the mean sought for being 103 deg. F. at the upper surface of the eggs, to correspond to the temperature of the hen's body. Even less so is there any mystery about the electrical incubator; in fact, its construction and operation are simpler than the kerosene-heated type.

The following description should enable anyone who is at all handy with tools to readily duplicate the electric incubator shown by the photographs. The cost of the materials complete is not quite five dollars, while a few evenings will suffice for its construction. The model shown by the illustrations has done excellent work, so that for those who wish to duplicate it as it stands, its dimensions are given. As a matter of fact, it could have been smaller and still have served its purpose equally well. This refers more particularly to its height.

Matched pine ceiling 3-8 inch thick was used, being screwed to 1 by 2-inch white pine framing, also screwed together. Screws were employed simply to avoid hammering; nails would do equally well though the screws made a stronger frame. This made a three-sided box, open at top, bottom and front, and with its frame plainly exposed inside. The space between the parts of the frame on each side was then filled with mineral wool and the frame covered with ceiling of the same kind as the outside, thus making a double-walled box with heat-insulating material in the walls. The front is of similar construction, except that it is hinged as a door and provided with a window, the details of its construction being quite as evident upon inspection of the picture as a description could possibly make them. The same framing material is employed with cross pieces inserted in addition to make a frame for the window. A slight recess is chiseled out of the frame to permit the glass to rest flush with it and the ceiling is then fastened down over it, the remainder of the door having been filled with mineral wool. The glass is double to prevent heat loss. At a point about on a level with the lower edge of the window two strips of the 1 by 2-inch framing are attached to the inner sides of the box to provide slides for the egg tray. This brings the eggs, thermometer and regulating device in plain view. The egg tray itself is made of ½ by 2-inch strips and ¼-inch mesh galvanized wire netting. The bottom tray is also of the same construction and is made removable for cleaning as the new arrivals are placed on this to dry off during the course of the hatch.

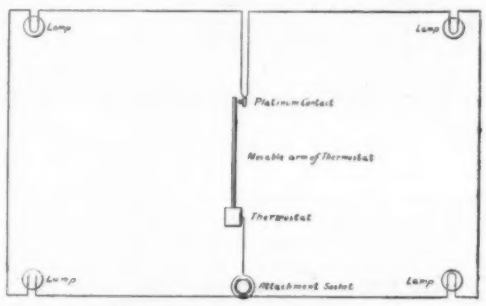


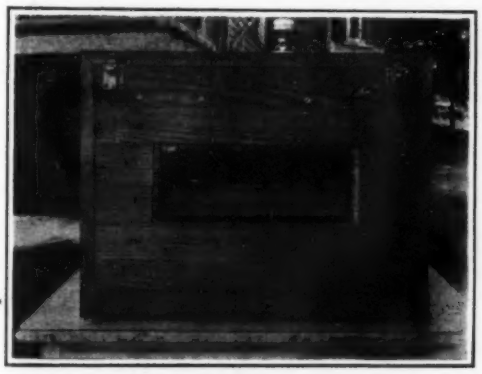
Diagram of wiring and thermostat.

The dimensions of the box are, height 17 inches, width and depth 22 inches. These are the outside dimensions, the inside being the same less the thickness of the walls. Through lack of foresight in planning the front construction it was necessary to make the egg tray somewhat smaller than would otherwise have been possible. As it stands it measures 15½ by 16 inches and has a capacity for between sixty and seventy hen eggs and forty to fifty duck eggs. This is ample for the amateur who keeps a small flock. The temptation to make or acquire a large incubator should be resisted as it must be borne in mind that hatching is only the first step, and unless given careful attention the mortality in a large flock of chicks will be high.

It will be apparent that this incubator could have been smaller without reducing its capacity, while a machine to hatch fifty eggs calls for a comparatively small box. "Hatch" in this connection is hardly correct. It should be maximum capacity, as there is always a substantial difference between the number of eggs put into the incubator and the number of chicks that hatch.

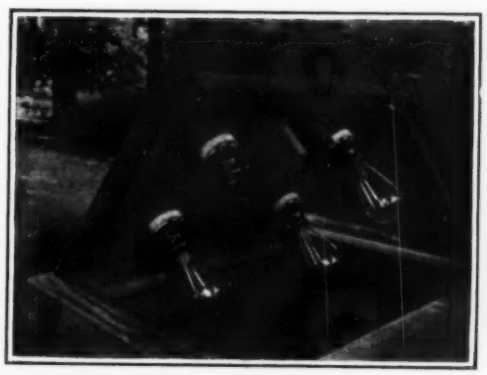
The mechanical details of the top construction are quite apparent. This top is double and has the mineral wool insulation, except at the edges, where it is of a single thickness in order to fit flush. It is not fastened in place in order to permit of removal for access to the lamps and thermostat, though for that matter experience in the use of the model illustrated showed this to be unnecessary, as they could be reached equally well through the large door, while a permanently fastened top would be more efficient where heat insulation is concerned.

So much for the mechanical construction. The electrical end is equally simple. The actual heaters themselves are nothing more or less than 16 candle power carbon filament incandescent lamps, of which four are employed. These are wired in two groups, the two lamps in each group being in series with one another, both groups being directly controlled by the thermostat. Their arrangement with relation to the latter will be plain upon reference to the wiring diagram shown. From one



Complete incubator, closed, showing window and egg tray inside.

Interior and removable bottom. The dish is for water.



Detail of top connection of thermostat. One lamp removed to show contact.

Details of heater and thermostat, one lamp removed to show contact arm.

side of the attachment socket, which is located centrally in the top, two wires are led in opposite directions to the two groups of lamps.

This wire is No. 14 "single braid" or rubber covered wire as used for incandescent lighting, and costs about two cents a foot retail. Connection is made at one side of the lamp, and another piece of wire employed for connecting the opposite sides of the two lamps, as shown by the diagram. This leaves open one connection on each of the two lamps belonging to the different groups. From these a wire is carried to the contact plate of the thermostat. The lamps are mounted in ordinary keyless sockets, costing about twenty-five cents each, directly on the inner face of the top of the incubator. By employing what are known as "sign receptacles" or some similar form of countersunk socket, two to three inches could have been saved in the height of the machine.

All the wiring and connections were carried between the two faces of the double top, and the distances are so short that no fastenings were necessary. After completing the connections the remaining space was filled with mineral wool and sealed up, holes having previously been bored and connecting wires carried through them for the thermostat. Upon the latter naturally depends the measure of success to be expected from the machine. The heat controlling device consists of an ether filled light sheet copper diaphragm of corrugated section such as is almost universally employed by incubator manufacturers. To increase its range and sensitiveness two of these diaphragms are coupled together. The device complete as shown was purchased from an incubator parts maker for $1.10.

As received it has a brass wire arm, ordinarily designed to carry a small disk or damper intended to open or close the vent in a lamp chimney. This damper must be discarded and an electrical contact substituted. Platinum is the best material for such contacts, as an insulating film of oxide rapidly forms on almost every other material, and such contacts caused the only trouble experienced with the incubator.

A carbon point to copper, direct copper and silver contacts were tried with poor results, as they wasted and fouled quickly, and were finally discarded for platinum, which was absolutely reliable.

By the aid of an obliging dentist two pieces of sheet platinum about ¼ inch square were obtained, and one of the pieces soldered to each of the contacts. Since then no trouble whatever has been experienced, and the regulation of the machine is so reliable that one almost gets the impression that the thermometer has "gone dead" with the mercury glued to the 103 deg. line. Except when the door is opened it would not vary so much as a fraction of a degree for twenty-four hours, regardless of changes in the outside temperature. Adjustment is made by means of a regulating screw on the thermostat which alters the distance between the disks and the lever, thus causing the latter to rise from the contact sooner or later. The machine reaches the proper temperature within two to three hours of being set, and from that time on the lamps never burn continuously, except for a few minutes after the door has been opened. They flash off and on intermittently, one second on, three to four seconds off, with such regularity as to give an excellent imitation of a flashing lighthouse. This serves to reduce the cost of operation, as the current is on for less than fifty per cent of the time, while wiring the lamps in series also tends to reduce the bill. In spite of both these factors, the cost of operation is high as compared with kerosene, the bill for running it 28 days with duck eggs being approximately $2.25 (rate 15 cents per kilowatt hour).

A slight amount of trouble was experienced with the regulation after a few days, due to the crude machine work of the thermostat. The regulating screw was such a poor fit that the vibration of surrounding objects caused by a person walking near by would shake it up or down with a corresponding variation in the temperature. This was not serious, as it was never more than a degree one way or the other, and usually only a fraction, but it was overcome by tinning the thread of the brass screw with soft solder, thus making it a tighter fit. Pieces of cloth or felt were put in the bottom tray during the hatch to prevent drafts reaching the eggs.

Hatching is only a small part of chicken raising, and a brooder is indispensable to take care of the newcomers as soon as they are able to get around. A brooder 24 by 24 inches, having ample capacity for the maximum number of chicks that the incubator could possibly hatch, was constructed for about $1.75. A frame this size was made, covered on one side with the same ceiling as the incubator, and four "sign receptacles" or countersunk sockets screwed to it. These were connected in two series groups with an attachment socket, no regulating device being necessary. The space was filled with mineral wool and the under side ceiled, this making four sockets facing downward and one upward. Four 5-inch legs of 1 by 2 stuff were then screwed to it at the corners, and old strips of flannel, woolen rags and similar material that came handy about the house were tacked along the top edge completely around. With a hole bored through the two layers of the top for insertion of a brooder thermometer, this completed a simple and effective hover. Four 16 candle-power carbon filament lamps provided the heat. It was seldom necessary to burn but two of the lamps (one series) to maintain the temperature in this hover at 90 deg. F., and for a considerable part of the time the current was off altogether. Only two of the hatch were lost in the brooder during their two weeks stay in it, and as they were not up to the standard of the others, it proved quite as successful as the incubator.

New Experiments of M. Eiffel*

Further Light on Aeroplane Problems

By A. J. A. Delaunay

M. Eiffel has just published a report on the first experiments made at his new Aeronautical Laboratory at Auteuil. This book is much more important than the previous one, giving the results of the experiments conducted at the original laboratory near the Eiffel Tower. It consists, in fact, of two volumes, one of about 400

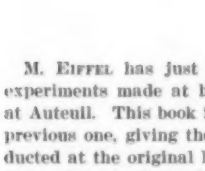


FIG. 1

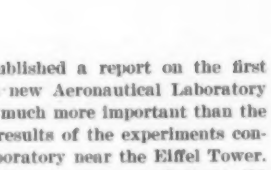


FIG. 2

pages containing explanations of the experiments and their application to various cases, the other consisting of the curves showing the results of the experiments.

It is impossible to give here a full account of this work, but we will take the general results and discuss them, chiefly where they can be compared with the results shown in the *Blue Book* recently published.

M. Eiffel still uses the same kind of apparatus as in his previous experiments. Instead of a wind tunnel similar to that in existence at the N. P. L. he cuts his channel in two parts and between them places a large room in which the experiments are conducted. This method is quite accurate: by measuring the velocity of the air in the air current, the difference between the velocity in a point in the air current and the mean velocity has been found (in the part where the models are placed) not to exceed on the average 0.5 per cent of the speed (the greatest difference found is 1.1 per cent).

Two cylindrical channels are provided: the larger one is two meters (6 feet 7 inches) in diameter, and the air passes through it with a velocity which can reach 32 meters per second (105 feet per second, or about 71.5 miles per hour), while the other is only one meter in diameter, but the air passing through it reaches a velocity of 40 meters per second (127 feet per second, or nearly 90 miles per hour).

The weighing appliances used enable the values of the coefficients K_y (lift for an area of 1 square meter at a speed of 1 meter per second), K_x (drift under the same conditions), the position of the center of pressure and the positive or negative pressure on the aerofoils to be determined.

In the reports of his previous experiments, M. Eiffel represented his measurements on aerofoils by a certain curve which he called a "polar curve." This curve is drawn by plotting the values of K_y against the values of K_x; but chiefly when K_x is very small (when the incidence is that of normal flight) the shape of the curve makes it difficult to compare two different wings. In the new report M. Eiffel keeps the general shape of the curve, but makes it more easy to read by plotting K_y against $5K_x$. Thus the difference between the shape of the curve for two wings appears more clearly.

In addition to this method, and chiefly in order to represent the measurements on models of complete machines, one of M. Eiffel's engineers, M. Rith, devised a new type of curve, called the "logarithmic polar curve," which makes it easy to solve all the usual problems which the aeronautical engineer wants to investigate when he intends to alter an existing machine.

Let R_x be the drift and R_y the lift on a model when the velocity of the wind is 10 meters per second, and R^A and R_y the drift and lift on the full scale machine when the speed of the machine is 1 meter per second.[1]

Now let P be the useful power necessary for displac-

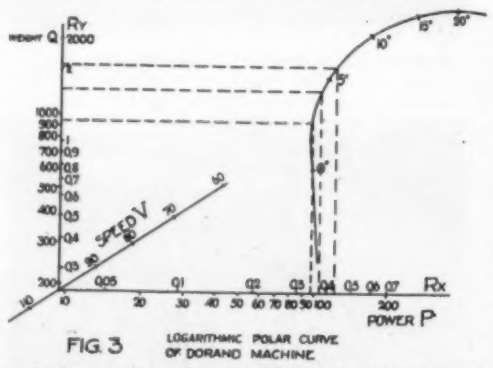


FIG. 3 LOGARITHMIC POLAR CURVE OF DORAND MACHINE.

ing the machine of which Q is the weight, and the speed V, then

$$P = {}_xV^3$$
$$Q = R_yV^3$$
$$(1)\quad \begin{cases} \text{log. } R_x = \text{log. } P - 3 \text{ log. } V \\ \text{log. } R_y = \text{log. } Q - 2 \text{ log. } V. \end{cases}$$

If now we are plotting log. R_y against log. R_x, the equations (1) mean that an abscissa log. R_x may be considered as being the resultant of log. P and -3 log. V, while the ordinate log. R_y may be considered as being the resultant of log. Q and -2 log. V.

But then the resultant of the two components -3 log. V and -2 log. V makes with the axis of log. R_x a constant angle, the tangent of which is 2/3 and its length is

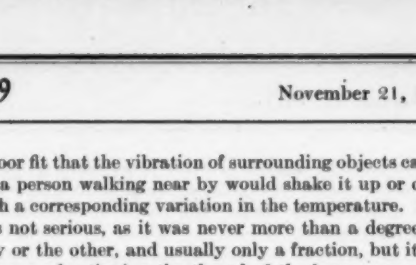


FIG. 4

$$\sqrt{3^2 + 2^2} \text{ log. } V = \sqrt{13} \text{ log. } V.$$

Then if we require a point on the curve, we can read it by taking the resultant of three components of which the directions are known and the lengths are proportional to log. P, log. V, and log. Q, and this point will represent the machine weighing Q kilogrammes flying at V meters per second with a useful power P.

The directions of the three axes log. P, log. Q, and log. V being constant, the point reached on the curve is always the same when P, Q, and V are constant, whichever is used in the first place.

We see that the "logarithmic polar curve" gives us at the same time the lift R_y, the drift R_x, the weight Q, the power P, and the speed V.

Furthermore, in the equation (2)

$$\text{Log. } R_x = \text{log. } P - 3 \text{ log. } V,$$

P is in kilogrammeters (1/75 of a metric horse-power, which differs only slightly from the English horse-power) and V is in meters per second. If P' be the power in horse-power and V' the speed in kilometers per hour, we shall have

$$P = 75\ P'$$
$$V = \frac{V'}{3.6}$$

and then

$$\text{Log. } R_x = \text{log. } 75 + \text{log. } P' - (3 \text{ log. } V' + 3 \text{ log. } 3.6).$$

This means that by changing the origin of co-ordinates we can use the amount of horse-power and the speed in kilometers per hour directly.[2]

* Reproduced from *Aeronautics*.

[1] If the scale of the model be 1/10 full size, and if we admit that the ratio of the lifts and drifts be in that case 1/100, we shall have $R_X = 100\frac{R_x}{100} = R_x$ and $R_Y = R_y$.

And as there are many figures that are useless, since, for example, we shall not have to design an aeroplane weighing 10 kilogrammes flying at a speed of 1 kilometer per hour, we can change again the origin of the co-ordinates and use only the part of the axes which represent the real cases.

Then we get a curve similar to the one shown here when the weights are varying from 200 to 2,000 kilogrammes, the power from 50 horse-power upward, the speeds below or above 100 kilometers according to the direction of the component V.

These curves enable an engineer to solve immediately a great many practical problems; we shall see below some of them.

1. The weight and the useful horse-power of the machine being known, what will be the speed and the angle of incidence?

Let $P = 70$ and $Q = 1{,}000$ (see Fig. 4).

We find immediately[3]

$i = 4.5$ degrees $V = 86$ k.p.h.

$i = 17.5$ degrees $V = 60$ k.p.h.

2. The weight being 700 kilogrammes, we wish to fly at 80 kilometers per hour. What will be the necessary power?

We find $P = 52$ horse-power and $i = 3$ degrees (see Fig. 5).

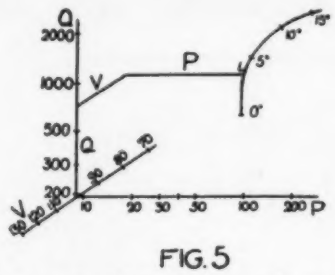


FIG. 5

3. We have $P = 60$ horse-power and we wish to reach a speed of 80 kilometers per hour. What must the weight of the machine be?

We find $Q = 930$ kilogrammes, $i = 5.3$ degrees (see Fig. 6).

4. What is the greatest speed attainable with a given horse-power?

The equation $P = R_x V$ shows that R_x must be as small as possible, which is the case when the ordinate Q is a tangent to the curve (see Fig. 7).

5. What is the greatest possible weight with a fixed speed? (Fig. 8.)

This is reached when P is tangent to the curve, when R^3 is maximum.

6. The weight being fixed, what is the minimum horse-power necessary?

If we mark Q on the axis of the ordinates and draw a line parallel to the axis of P, the P will be minimum when the V component is drawn as much as possible toward the left, namely, will be a tangent to the curve.[4]

7. What is the smallest propeller thrust F which renders flight possible, when the weight is given? (Fig. 9.)

We have

$$\frac{F}{Q} = \frac{R_x}{R_y}$$

$$\text{Log.}\frac{F}{Q} = \text{log. } R_x - \text{log. } R_y$$

$$\text{Log. } R^3 - \text{log. } R_y = 0$$

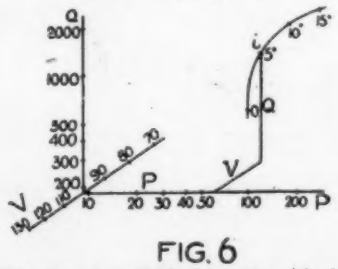


FIG. 6

is a straight line N of which the angle with the axis is 15 degrees.

For a given value of $\frac{F}{Q}$ the two corresponding points on the curve will stand on a line parallel to N, and the minimum value will be reached when the parallel is a tangent to the curve.[5]

Various Experiments.—M. Eiffel has made a number of experiments in order to ascertain the influence of changing the velocity of the wind. While the resistance coefficient of a circular plane is nearly constant when

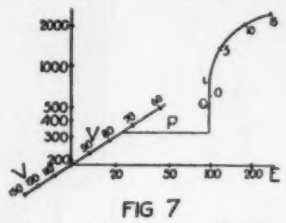


FIG 7

the velocity changes from 4 to 30 meters per second in the case of spheres, cylinders, streamlined struts and dirigible bodies, the head-resistance coefficient decreases when the speed increases. In the case of spheres or cylinders a limit value seems to be reached when the speed is about 20 to 24 meters per second, but this limit changes with the dimensions of the tested bodies.[6] In the case of cylinders it must be noted that, in accordance with Dr. Thurston's experiments, the resistance decreases when the length of the cylinder increases.

Regarding streamline bodies, the limit value of the resistance coefficient was not reached when the speed was 40 meters per second (89 miles per hour). It may be noted that some experiments show the influence of skin friction, since when two bodies have the same diameter, the same fore and aft shapes, and differ only in the length of the cylindrical part, the smaller this length, the smaller is the head resistance.

M. Eiffel has made some new experiments regarding the influence of speed on the resistance of wires: in the case of piano wires the speed does not seem to be of great importance. The resistance of cables at small speeds is less than the resistance at high speeds, and a small cable has the same head resistance as a piano wire; but the resistance increases with the diameter and for cables of ⅛ inch K would be about 0.072.

Aerofoils.—One of the most important questions relating to the resistance of aerofoils is the possibility of an increase in efficiency when the size and speed increase. In the Technical Report for 1912-1913 it is

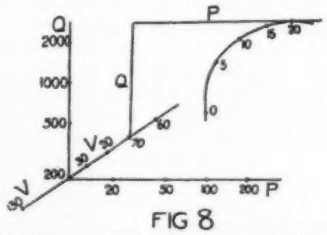


FIG 8

assumed that it is indifferent to increase the size or to increase the speed of a model. In the August issue I gave the results of comparative experiments at St. Cyr and M. Eiffel's Laboratories, showing the influence of actual size. M. Eiffel tested several wings at different speeds, and his results are as follows:

The aerofoil No. 30 was tested at 10, 20, 30, and 40 meters per second. The measurements gave figures which did not differ by more than 2 or 3 per cent, which differences can be imputed to errors in readings. Consequently, the ratio Lift to Drift is nearly constant for that shape of aerofoil. With the aerofoil No. 32, which is very slightly double curved, there was noticed, on the contrary, an increase in efficiency. The Lift coefficient was not altered, but the Drift coefficient was decreased and the efficiency increased at high speeds for the small

Speed in met. per sec.	Angles of Incidence. 0°	3°	6°	9°	12°	15°	
10	7·5	12·35	13·1	11	8·75	6·15	Lift
20	13·3	16·1	16·1	11·8	8·7	6·15	Lift
30	15·85	18·1	16·4	11·9	8·9	6	Drift

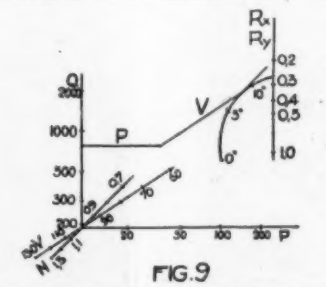


FIG. 9

[3] It would be quite as easy to use the power in horse-power and the speed in miles per hour.

[4] We find here the two speeds to which I have referred in my previous article on "Safe Landing." If it were taken into account that the efficiency of the propeller is not the same at both speeds, we should have another value for the low speed, which would be obtained by following the dotted lines AD.

[5] Here we have the "neutral attitude" of which I spoke in the July number of *Aeronautics*.

[6] It must not be forgotten that if it is required to go from one point to another (in fine weather) as economically as possible, it is necessary to fly so that F is minimum.

[6] The results on spheres are in accordance with the results of experiments made by Capt. Costanzi in water (*Rendiconti delle esperimenti della Brigata Specialista*) and the Aeronautical Laboratory of St. Cyr in air. In all these cases there is a drop in the resistance for a certain value of the speed, which value depends on the diameter of the sphere. Lord Rayleigh pointed out that in this case the product vd should be nearly constant, but this is not shown by the above experimental results.

angles of incidence. The reverse occurred when the angle of incidence was larger than 14 degrees as shown by the accompanying table.

The great difference between these two cases shows how difficult it is to generalize the results obtained on one type of aerofoil.

In other experiments M. Eiffel tested aerofoils which were of varying thicknesses; in one case the bottom curve was not changed, while in another the middle curve was kept constant. These tests, together with some on special types of thick aerofoils, made it clear that in the case of thick aerofoils the resistance was greatly modified when the speed was changed, and it is sometimes possible to get, for certain angles of incidence, two values of the lift coefficient. At any rate, these experiments seem to prove that it is better in a set of aerofoil sections for use on a propeller, to keep the middle curve constant rather than the bottom curve.

From a similar series of experiments on the influence of aspect ratio, M. Eiffel concludes that by diminishing the aspect ratio the lift coefficients are decreased and the drift coefficients are increased. But it must not be concluded that the same value of aspect ratio is the best for every type of wing; with the aerofoil No. 31 the best tested aspect ratio was 6, but for another type of camber it has been found that the best aspect ratio, when K_y is less than 0.3, is 5.

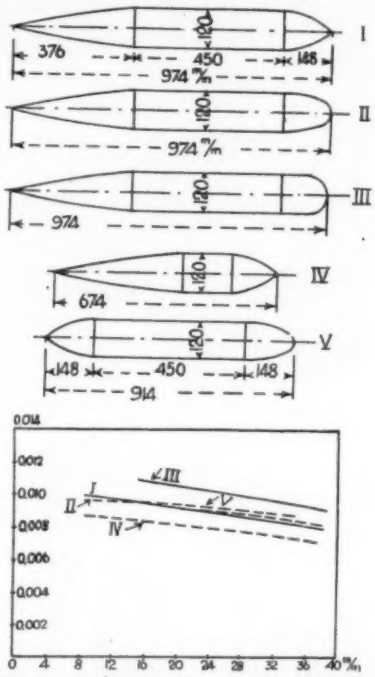


Fig. 10.—Resistance of streamlined bodies.

As to the plan forms of wings, it seems that a wing in which the trailing edge is longer than the leading edge is slightly more efficient than a rectangular one. In this part of the book M. Eiffel gives experimental data relating to more than forty different types of wings.

Experiments of Models of Complete Machines.—The part devoted to the experiments on models of complete machines is very important, and results are given for nineteen types. It is very difficult to give an account of them. We shall only give a few figures relating to the applications of results to full scale machines.

Machine.	Weight (lbs.)	Loading per sq. ft. (lbs.)	Maximum speed (miles per hour).	Useful HP at max. speed.	Minimum possible useful HP	Speed at min. HP	Maximum Lift / Drift.
MONOPLANES							
Drzewiecki ..	1575	5·6	66·5	50	43	57	6·15
Blard	1060	4·9	61·5	35	26	47	5·5
Bleriot	880	5·4	59	35	23	46	5
Morane (Mono) ..	1050	6·1	72	50	23	46	5·9
Do. (two-seater)	1210	7·05	71	50	29	50	5·9
Paris	1100	6·4	67	36	19	49	8·5
Tatin	396*	4·1	51	7·5	6·5	43·5	7·6
Bristol	1760	5·45	73	70	24	54·5	6·2
BIPLANES							
Dorand (1909) ..	1695	3·5	43·5	42	37	37	4·9
M. Farman (mono)	1610	3·4	46	50	35	34	4·4
do. (two-seater)	1760	3·35	44·7	50	40	36	4·4
Breguet (two-seat)	1980	5·1	88	49	36	43·5	7·05
do. (three-seat)	2380	6·15	60·3	58	48	47·5	7·05
SEAPLANES							
Colliex-Jeanson ..	7850	6·4	59·5	275	225	51	5·1
Breguet (Marseillaise)	2980	8·3	77·5	80	60	59	8
Nieuport	1870	7·75	62·5	60	42	49	6
Paterras Pascara	6150	8	67	200	152	51·5	5·8
Alvarez et de Conde	1320	4·85	60·2	35	24	43·5	7
Max Oertz ..	2310	5·1	62	70	48	46	6·1

The models were also tested with a view to ascertaining their static equilibrium, namely, to know if, in case of a change of incidence, there was produced a couple bringing the machine to its normal attitude; with the exception of the Maurice Farman, in which the righting couple is very small, and the Tatin, which was not tested, all the machines were found to be stable in this respect.

Treatment room of an English hospital train.

Pharmacy room of the converted ambulance train.

The Care of the Wounded

A Vast and Complicated System of Which Little is Heard

THE first object of an army in war is to disperse or destroy the enemy, but a correlative duty is the care of its own men when wounded or otherwise incapacitated for service; and this involves a very extensive and carefully systematized service that has been as thoroughly studied and developed as the maneuvers of the fighting men. Although the results of the modern systems of handling and caring for the wounded must necessarily, to a great extent, depend comparatively on the differing local conditions, the work now being done is in every respect a vast improvement over that of previous wars, owing both to experience gained and to constant improvements in medical and surgical knowledge.

In the case of a battle, the first proceeding is to locate the injured men on the field, and a late number of the *Umschau* contains an interesting plea for the use of trained dogs in the search for wounded after a battle. The claim is that thereby great mortality would be prevented, as the dogs could find the badly wounded lying in thickets or obscure places, thus bringing speedy aid to helpless men who might otherwise die in agony from neglect. The article is by a German cavalry captain named von Stephanitz, and the curious fact is that it was written just before the mobilization of the German army. The outbreak of the war leads the author in a note to state that such dogs are already being tested by actual use and to urge contributions for a further supply of them.

Former wars have shown that wounded who are unable to reach the field hospitals themselves, or who cannot be brought there, often exert their last strength to reach shelter of some kind in the open, in order to escape further wounds or the danger of being ridden or driven over. Others of the severely wounded remain lying on the spot where the shot struck them, and these spots are often not easily found, especially in approaching twilight, and, above all, at night. For, although during a battle the wounded are given such care as is possible by the ambulance corps, yet the carrying of the wounded to the field hospitals from the district under fire is generally only possible after the firing has ceased, nor can a systematic search of the battle-field begin until then. And yet all wounded men ought to be found and carried where they can receive surgical aid as quickly as possible.

Even should the ambulance corps and its assistants exert themselves to the utmost to accomplish their task, nevertheless every region contains spots where wounded could be overlooked, and unfortunately are overlooked. This is proved by the number of "missing" in the reports of losses. Search should be made in fields of standing grain, in ditches, behind hedges and bushes, or in spots where the searchlight cannot penetrate or throws heavy shadows; above all, there is danger of such being overlooked in the undergrowth of woodland.

The author in setting forth his views, which deserve all the more attention as coming from a military man, continues:

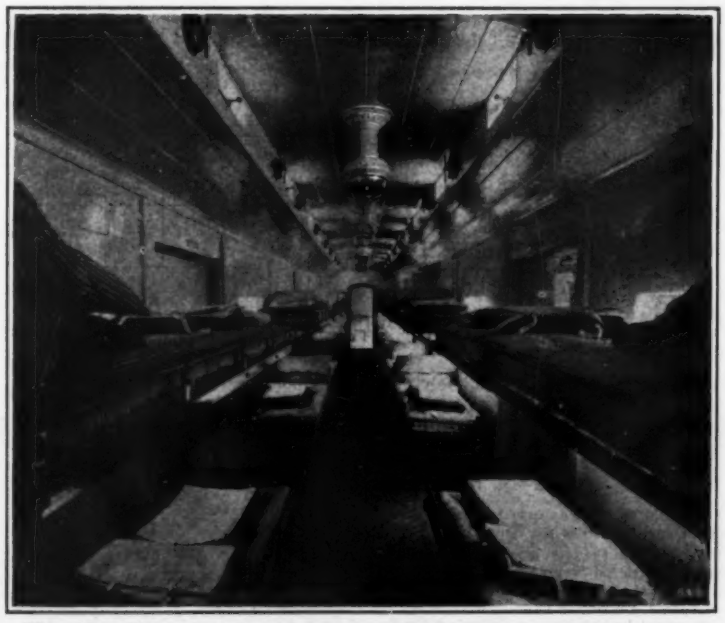
"Searching has its restrictions, as has already been shown, in the limitations of the human perceptive faculty, above all in those of the eye, and under certain conditions also of the ear.

"But there is a willing assistant with keen senses, the qualities and perceptions of which mankind has known how to use for thousands of years—the dog. The use of the dog for charitable work is nothing new, as is shown by the well-known dogs of the Hospice of St. Bernard. Even police-dogs in their night searches often scent out helpless people or drunkards in obscure spots off from the roads. For finding the wounded the use of dogs, ambulance-dogs, is of much importance. The dog's chief organs of sense, the nose and ear, supplement and complete those of the detail for finding the wounded; the scent for the game is in the blood of some breeds, and can be developed in others by suitable training. A dog's build enables it to race ahead of the searchers, especially on reaching thickets which the men can

Photo by International News Service

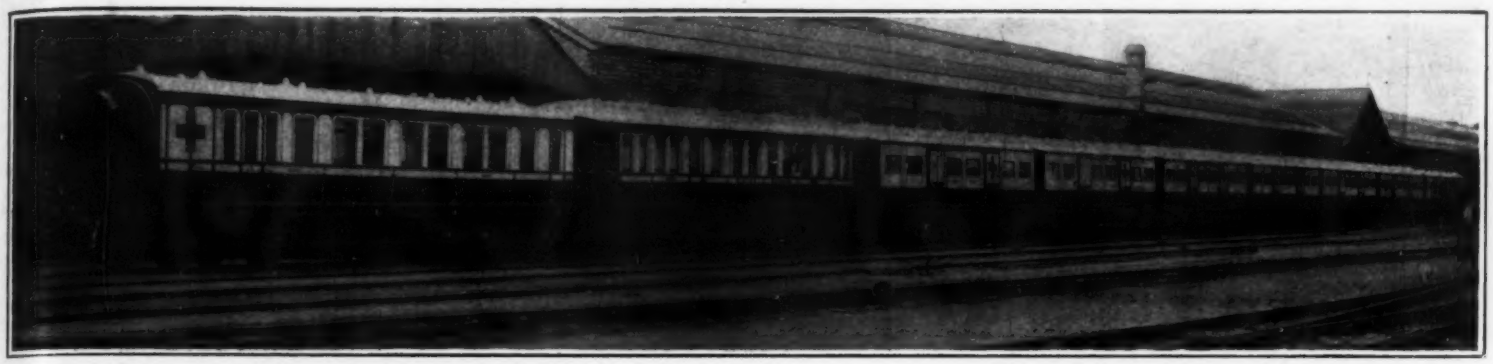
Major Richardson of the British army and two of the famous hounds that he has trained for Red Cross work on the battlefield.

Major Richardson is well known for having introduced the dog into the police service.



View down the center of ward car of an English military ambulance train, showing fixed berths and cots.

In the center of each train is a pharmacy car with treatment room, office, and all necessary supplies.



One of the four new railway ambulance trains constructed by the London & North Western Railroad Company for the transportation of wounded soldiers in England.

The vehicles were taken from mainline traffic and altered for hospital use in thirty hours.

German Red Cross prisoners.

Red Cross nurses on the French side.

Wounded French and Germans in a Belgian church used as a hospital.

A wounded Turco being carried to the ambulance.

Photo by Meurisse

German prisoners in front of the church of Neufmontiers.

A wounded Turco supported by his comrades.

The first field dressing packet.

The field dressing packet is carried in a left-hand pocket in the lining of the coat. On the outside of the wrapper are full directions for use.

Identification disk worn on active service.

The identification disk is served out to all soldiers in the British army at the beginning of active service. It is made of aluminium, and is worn by a cord round the neck. On the disk are punched in raised letters the wearer's name, regiment, official number, and religion.

The emergency rations packet.

This packet is carried in a right-hand pocket in the lining of the coat, and is ready to hand when needed. The packet is small and compact and takes up very little room.

scarcely enter. While thus going on ahead, its quick ear hears the breathing of a wounded soldier, or a puff of wind carries to it the scent of someone in a lonely spot."

The advantages resulting from the use of ambulance-dogs have been long known. As far back as 1893 a society to promote their use was formed in Germany, and similar societies were founded in Belgium, Denmark, France, England, Italy, the Netherlands, and Sweden. To some degree official efforts were made in these countries to encourage the maintenance of such dogs, but these efforts did not go much beyond good intentions and mere beginnings, because the ambulance-dog, while a necessity in war, is of no use in peace. That is, these dogs cannot be kept in sufficient number for real use in warfare without a disproportionate outlay in labor and cost of upkeep.

There is in Germany a "Society for German Sheep-Dogs," which is the largest amateur breeding association in that country. This association was the first to urge the use of police-dogs, and since the movement for police-dogs has grown stronger, the society has constantly insisted that the police-dog service has solved the problem of maintaining a breed of dogs suitable in war for ambulance-dogs. Among the breeds inspected for this work were the dogs used by the gendarmes, those used by the officials of the custom-houses at the frontiers, those kept by foresters, and by the country police. These were dogs accustomed to all kinds of weather, to long runs, and work in the open in finding the game. After experiments had been tried with these, the "German Society for Ambulance-Dogs" resolved to take up the work also and to breed a supply of ambulance-dogs, as well as to train leaders for these dogs in war time. Any further steps in the matter would depend on the attitude maintained by the proper authorities.

Naturally neither all dogs nor all breeds of dogs can be used with an ambulance. The only suitable ones are hardy dogs inured to all kinds of exposure, of a build capable of prolonged exertion. Consequently, there only remain the four breeds from which the police-dogs are chosen: German sheep-dogs, the Dobermann terrier, the Airedale terrier, and the Rottweiler. Of these four breeds the sheep-dog is by far the most numerous.

In winding up his earnest appeal for a good supply of such dogs, the captain says:

"Naturally, the dogs must be completely bare during the search. All equipment, even a collar, might only expose them to the danger of being caught and unable to push forward when working their way through a heavy thicket. The fine-sounding suggestions that ambulance-dogs should be equipped with the Red Cross, bottles containing refreshing drinks, bandages, note-books, little bells, or even lanterns, are mere puerilities, worthless, if not dangerous, in actual use. The ambulance dog should have nothing to do but to find, to find as quickly as possible, in order that the wounded thus found may soon have human aid and care."

HOW MANY WOUNDED MUST BE PROVIDED FOR?

In developing any intelligent or practical system for handling the wounded, as well as those incapacitated by sickness, it is necessary to know how many patients will require treatment, and furthermore, for what periods of time; for some will need but a few minutes attention on the field, while others will require long and careful treatment. How these questions are determined is told by Major F. A. Symons, M.B., R.A.M.C., in the September issue of *Blackwood's Magazine*.

"In preparing for the treatment of the wounded one must have some idea as to what the likely requirements are to be. How many wounded are to be expected from each engagement? To the uninitiated this question seems unanswerable. In a sense, of course, it is unanswerable. And yet it is upon definite figures of probabilities that all the regulations of the army in the field are based.

"Let us take an army division as our unit for study. A division in war comprises some 18,000 men. Statistics, based on all great previous wars, point to certain average facts, which may be summed up as follows:

"Out of this 18,000 men only about three fifths will be actually engaged with the enemy. The remainder, employed in various non-fighting capacities for the moment, become for the purposes of calculation a negligible quantity. Say that 10,000 men are engaged. Of these, 10 per cent must be expected to become casualties—i. e., 1,000. Of this 1,000, 20 per cent will be killed. This leaves us 800 to deal with. Of this 800, 20 per cent will be able to walk to what is called the Divisional Collecting Station. There, having received what surgical aid they require, they will remain until the end of the engagement, and then return for the remainder of their required treatment to their units; 640 are therefore left for admission to hospital; 60 per cent (of the 800) can be carried in the ambulance wagons, sitting up; 15 per cent will require lying-down accommodation; and 5 per cent will be unfit to be moved from the place where they fell.

"It will readily be seen, therefore, that the Army Medical Service in the field starts forth with a fairly shrewd idea as to what it may be called upon to face."

Different systems prevail in different countries, but the writer goes on to describe the British organization, which represents the methods followed generally:

"Let us start with the battalion of infantry. Each company boasts of two 'regimental stretcher-bearers,' who, having been trained in first-aid work, carry a stretcher. At the beginning of an action these bearers, under the command of the medical officer attached to

The cuts on this page are from *The Sphere*

Fig 3
Safety Pin, wrapped in waterproof paper stitched on packet
One of the 2 Packages (identically the same) contained in the outfit
Arrow on label shows which corner (being uncemented) of the waterproof wrapper to open first

One of the two packages in the outfit.

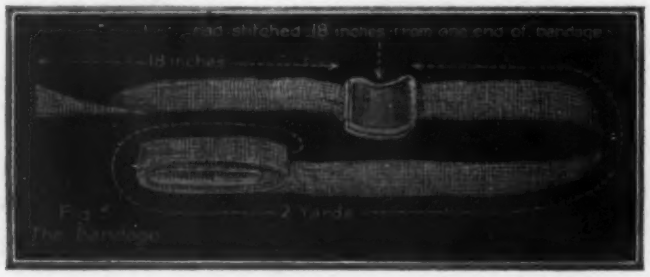
Both packages of dressings are identical. The arrow on the label shows which corner of the waterproof wrapper is to be opened first. The corners are securely cemented with rubber solution.

Packet containing field dressings included in the outfit of every soldier.

A piece of bleached cotton gauze 36 x 28 inches (360 grains weight) folded into a pad 4 x 3½ inches and stitched to bandage
A loose bleached cotton bandage 2½ yards long & 2½ inches wide
Safety Pin stitched to wrapper
Waterproof jackonet edges cemented with rubber solution to render packet airtight
Fig 4
Opening one of the Field Dressings

Opening one of the field dressings contained in the packet.

The field dressings contained in the first-aid packets have a waterproof outside covering with the edges cemented with rubber solution to render the packet tight. Stitched to the wrapper is a safety pin for use when bandaging wounds. Inside the wrapper is a loose bleached cotton bandage 2½ yards long and 2½ inches wide, and a piece of bleached cotton gauze folded into a pad and stitched to the bandage.



The bandage—showing the pad stitched 18 inches from one end of the bandage.

Applying the first field dressing to a wound.

The pad is applied over the wound and then the bandage is wrapped firmly and evenly, according to the directions given, and the ends secured by the accompanying safety pins.

Opening the packet containing the two field dressings.

the battalion, fall to the rear, and are located as the medical officer sees fit. A soldier falls, wounded. First-aid is at once applied by the bearers, and the wounded man carried to the shelter of a rock, ditch, or trees, close at hand. If the wound is particularly serious the medical officer intervenes. The latter cannot, however, be everywhere at once, and the battalion, in open order, may cover almost a mile of country."

In this connection attention may be directed to first-aid field dressing and emergency packets that in some form are in use by most European armies, and are ready for instant use when a man is wounded, and will save much suffering, and many lives that would be sacrificed if the injured had to await the arrival of a surgeon. The packets used in the English army are fully illustrated and described in the accompanying cuts.

It will be noted that this is purely regimental work, and not directly attached to the regular ambulance service, which now takes up its work.

"There are three brigades in a division, and each of these is provided with one field ambulance, consisting of three sections, which may either work together or over separate zones. Each section is again subdivided into a bearer and tent subdivision. In action one tent subdivision is usually pushed forward as near the fighting line as safety will permit, in order to establish a dressing station.

"From this station the bearer subdivisions, equipped with stretchers and supported by ambulance wagons, start forth to search for wounded. In order to insure that no wounded are missed, and also for the sake of avoiding overlapping, each bearer subdivision is appointed to a definite area of the fighting zone, marked out on the map."

From the regimental aid posts, previously mentioned, the bearers collect and convey the wounded to the "collection station," where the ambulances have been assembled, by which all are taken to the dressing station. Here the wounds requiring it are dressed afresh, and urgent minor operations performed. It will be found here that many men require no further treatment except what they can obtain at their regiments, to which they are at once returned. The others are loaded into the ambulances, or other conveyances, and taken to the rear, out of shell fire, where a full tent division of the field ambulance will be found. This, however, is a mobile unit that is required to follow up the army closely, and as it may be required to move at any moment the wounded are not kept there longer than necessary. There is, however, plenty of food and medical necessaries.

From this field station the wounded are rapidly transferred to the nearest railroad, and thence to various stationary hospitals, or to the base hospital, according to the length of time the patient will require treatment. The number of these transfers will depend on the distance of the front from the base, and the facilities for transportation; but it will be seen that a constant sorting process is operating to return men slightly injured to their commands as quickly as possible, thus relieving pressure on the hospitals, and only serious cases reach the base.

This writer also notes the fact that the British army now has a "sanitary service" under skilled officers, which is expected to counteract the ravages of disease that have been so fatal to armies in the past. This service will include the inoculation of the men against typhoid and enteric fever, a method that has been proved most effective in India, the South African war and elsewhere.

OPEN AIR HOSPITALS.

The subject of caring for the wounded has raised the question of the efficiency of the primitive stations denominated as hospitals, and in this connection an article on "Open Air Hospitals in War Time," by Prof. Robert Saundby, of the University of Birmingham, published in a recent issue of *The Lancet*, is most timely and interesting. The professor's summing up of facts and observations that have been well known for years, but for some reason generally ignored, is as follows:

"The usefulness of hospitals is almost in inverse proportion to their architectural merits and our exaggerated notion of 'comfort' is inconsistent with healthy surroundings. Draughts of air, low atmospheric temperature, and dampness are not the disease-bearing agencies they were once supposed to be, while bad ventilation and equable warm temperatures are depressing, debilitating, and retard recovery. Even dampness does no harm where there is a good current of air."

Further on he says: "Why have we been so slow to recognize that fresh air is the best tonic, the best antiseptic? It is cheaper, pleasanter, and undoubtedly more efficient than drugs." And he quotes from the report of Surgeon-General Billings, who says in his report of the medical and surgical history of our civil war, speaking of hospital construction: "The object to be kept in view is to furnish shelter without diminishing that supply of pure air and light which is necessary to health."

From this it can be safely inferred that the sufferers in the present war will have fully as good a chance of recovery in the open tent hospital of the field, or possibly a better one than if treated in one of the showy structures of which all great cities are so proud.

NEW AMBULANCE RAILWAY TRAINS.

On arrival from France and Belgium at the various ports and harbors on the south and east coasts of England, the British wounded soldiers and sailors are conveyed to hospital bases at various selected inland places in a number of specially constructed ambulance trains, several of which have been provided by each of the leading British railway companies. Four of these new railway ambulance trains have been constructed by the London and North Western Railway Company, three being for the War Office and one for Admiralty, of which some illustrations are given. The vehicles were taken from main line traffic and altered to suit required conditions, and the trains were completed in 30 hours. The center vehicles are for the accommodation of patients, those at either end being for the convenience of the staff, stores, etc. In the military trains the ward or hospital cars have a pharmacy car in the center. All the carriages were thoroughly well cleaned inside and outside, overhauled, revarnished, and the whole of the interior finished in white enamel, and special ventilators were fitted in the clerestory roofs. The ward cars were converted from open parcel vans, which were already provided with sliding doors on the sides and ends. These were refloored, covered with linoleum, coved at all angles, and hooks were fixed in the ceilings for suspending cots in two tiers on both sides, for the naval train, and folding berths, in two tiers hinged to the sides for the military trains. The pharmacy car in the center of each train is subdivided into treatment room, pharmacy, office, linen stores, etc., and fitted with all necessary requirements such as cupboards, shelves for drugs, medicines, bandages, and utensils. Dining cars are attached to each train, for providing meals, etc., for the staff and patients; and the trains are vestibuled throughout.

CHARACTER OF WOUNDS.

In considering the treatment of the wounded in war the nature of the wounds becomes a matter of importance. The modern rifle shoots a small bullet at a very great velocity, and although there may be some slight variation in the action of the bullets used by different nations, as there are differences in size, shape, and velocity, still at the present time all classes of modern army bullets are supposed to behave practically alike, and opportunities for studying their action and effect have occurred in our war in Cuba, in South Africa, and other places.

From these observations it appears that between the distances of 300 and 900 yards the wounds made are of a penetrative character, even in the case of bones, and unless foreign matters, such as bits of clothing, are carried into the wound, there is seldom any infection, and the wound heals rapidly without trouble. At shorter or longer distances the action of the bullet is erratic, splintering bones badly, and frequently turning over so that it strikes sideways, producing lacerated wounds. These effects are also liable to be produced at any range if the bullet strikes some object, and is deflected in its course. Another effect produced by these high velocity bullets is a disruption of the softer tissues of the body that often leads to the impression that an explosive bullet was used; but the exact cause of this action, and the conditions under which it takes place, is not understood.

That the wound made by the modern high velocity bullet, covered with its nickel jacket, is more or less aseptic, and that a large proportion of the wounds made by them are not of a serious nature, and give but little trouble, has been demonstrated by the records of the conflicts mentioned above. In this respect the work of the army surgeon of the present day has certainly been simplified, and the percentage of fatalities from bullet wounds in the present war will show a material decrease.

Disinfecting the Mouth with Ultra-Violet Rays

It is well known that the ultra-violet rays, those "dark rays" or radiant energy which lie just beyond the violet end of the solar spectrum, have the power of killing bacteria. They have been used successfully to sterilize water, and it is to them that the power of sunlight to kill germs is due. The bactericidal power of the sun is relatively small, however, because these rays, which have a very short wave-length, are largely absorbed by the atmosphere before they reach the earth.

To obtain an intensive effect of these rays, therefore, they are produced by an artificial source. The ultra-violet rays from the mercury lamp are very deadly to bacteria. Finsen, notably, has used them with great success to treat superficial skin diseases, especially lupus. They are not adapted, however, to the treatment of diseases when the bacteria have involved the internal parts of the body, since, owing to their short wave-length, they cannot penetrate the deeper tissues.

Recently, however, it occurred to a German physician, Dr. E. Friedberger, and his Japanese colleague, Dr. E. Shioji, that these rays might be employed, by means of a suitable apparatus, to disinfect those cavities of the body which have an external opening, especially the mouth and nose. These are peculiarly important, because they are the port by which many dangerous germs enter the body. An account of their experiments is contributed by these investigators to *Die Umschau* (Frankfort). We read:

"We need name only the germs which cause inflammation of the lungs, tuberculosis, infantile paralysis, and, above all, diphtheria, among the very various germs which enter or have their chief location in the cavity of the mouth, of the nose, or on the tonsils. The possibility of killing the germs in those cavities, therefore, is highly important. The more so from the point of view of epidemics, since it is well known that some persons on recovering from a disease become 'bacillus-carriers,' while others, though not themselves ill, are known as 'go-betweens' (Zwischentrüger), who carry germs from one person to another."

Since irradiation from outside is not very effective, owing to the law that the intensity of the rays and their germicidal power decrease in proportion as the square of the distance increases, Dr. Friedberger and Dr. Shioji endeavored to construct an apparatus which would enable them to place the source of the light within the mouth itself.

"We have applied a special device of quartz to the mercury lamp and began our experiments with guinea-pigs, placing this device directly within the mouth. The mouth of the guinea-pig, like every cavity of the body which has an external opening, is filled with countless numbers of bacteria. We proved that irradiation of the mouth for only a few minutes sensibly diminished the number of germs, and that after twenty minutes there was practically a total destruction of them. This may be illustrated by an example. The following results were obtained by alternating five-minute periods of irradiation and cessation:

NUMBER OF GERMS ON THE AGAR PLATE.

Before irradiation	114,000
After 10 minutes' irradiation	85
After 20 minutes' irradiation	5
After 30 minutes' irradiation	3

"Similar experiments were also made after enormous quantities of diphtheria and other germs had been introduced into the mouth of guinea-pigs. In these cases also the irradiation quickly destroyed the germs.

"The following results were obtained by similar experiments with the *bacillus prodigiosus*. Before the irradiation there were numberless colonies of *prodigiosus*.

	Colonies.
After 10 minutes' irradiation	318
After 20 minutes' irradiation	1
After 30 minutes' irradiation	0
After 24 hours' irradiation	0

"The next step is to investigate to what extent this method may be applied to all possible human diseases of the mouth cavity, especially diphtheria. A difficulty is found in the circumstance that even ten minutes' application of the ultra-violet light is sufficient to cause a burn."

Soil Erosion in South Africa

At a recent agricultural meeting in South Africa one of the principal topics of conversation was soil erosion, a subject which is of growing importance in the stock-raising districts on account of the rapidity with which vast tracts of land are becoming practically sterile. It has been suggested that the soil erosion which is going on in South Africa is due to the natural and inevitable desiccation of the country, but the consensus of opinion at the meeting was that it was due to the destruction of the grass which naturally binds the surface soil and forms a retentive mass that absorbs moisture and prevents the rapid run-off of rainfall. The destruction of the grass was attributed to two causes: the indiscriminate burning, frequently just previous to the wet season, and the constant driving of cattle along the bottom of natural hollows. There are numbers of examples of the drying up of vleis, and in every case one can attribute this to the formation of a river which started first as a small sluit and gradually developed into a larger river.

Some Novel Slow-Speed Motors

A New Power System Utilizing Different Voltages

THE new type of three-phase motor which is conducted by the Oerlikon Works is of interest from the fact that it runs at several speeds, and is designed for very slow speed work and heavy flywheel effect. Such motors are very useful, for instance, for direct drive of

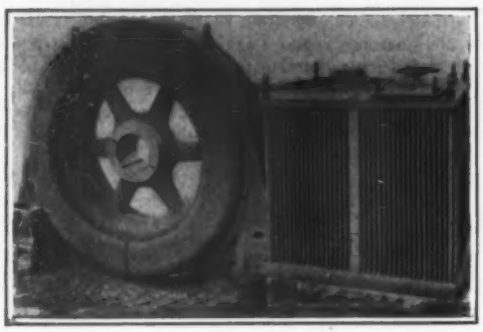


Fig. 1.—Oerlikon motor for various speeds, with its transformer and controller.

piston pumps, and can thus be employed in a great number of plants in which there is required a very slow speed with a good range of speed regulation. Fig. 1 shows the new type of motor, together with transformer and motor-starter. A number of these motors were installed in one of the large coal mines in Cornwall, where they serve for piston pumps on direct drive. The design is that of a short-circuit motor with the rotor in flywheel shape, so as to overcome irregularities in the running, and have the following conditions:

Speeds.	First.	Second.	Third.	Fourth.
Power, horse-power.....	35	55	72.5	110
Number of poles.....	72	48	36	24
Revolutions per minute...	38	60	82	118

The voltage is 2,700 to 3,000 volts, and frequency 25 cycles. Motor starting is done by starting transformers which are mounted together with pole-changers. According to the specifications, the motors were required to start upon 2,700 volts and have a starting torque equal to the normal. Conditions of temperature and dampness in the mine where the motors were to be installed are specially unfavorable, there being a mean temperature, 37 deg. Cent. and dampness 80 to 85 per cent, so that the coils had to be impregnated several times as protection against dampness.

In designing motors for this class of work, the first idea was to use the high-tension current directly in the motor itself, but further considerations showed that both motors and transformers would be cheaper to build, and would work with less trouble, if the transformers were not designed for mere starting but to take the whole of the power, the motors, on the other hand, to work upon low tension. In the present make-up, the stator of the motor has two sets of windings, one for 24 and 48 poles, and the other for 36 and 72 poles. Owing to the construction of the transformer and pole-changer in one apparatus, this allowed the choice of the best voltage to use on the motor for each combination of poles, so that the windings can be made as bar windings on the stator. The increased cost due to the use of transformers for the whole power, instead of for starting purposes, was amply made up by the more simplified windings and also by the smaller size of the motor. The stator is seen in the rear in Fig. 2, and the winding is laid in 432 slots, the winding used for 24 or 48 poles being composed of forty-eight sets of coils per phase. Connections are seen in the diagram, Fig. 3, six terminals being used. Nos. 4, 5, and 6 each come off from twenty-four sets of coils. If the motor is to work on 48 poles, the current leads are joined by the starting switch to ends Nos. 1, 2, and 3, while ends 4, 5, and 6 are free. For 24-pole working, the current is now put on 4, 5, 6, and 1, 2, 3 are short-circuited.

The system of winding for 36 and 72 poles is composed of 72 coils, and is placed as near as possible to the air gap so as to lessen the dispersion which is greater than with the other pole-set. Connections for these windings are shown in the diagram, and here six terminals are also used. Nos. 14, 15, 16 come out at each set of thirty-six coils. Where the motor works on 72 poles, the switch puts current on Nos. 11, 12, 13, while the others are free. For working at 36 poles, 11, 12, 13 are short-circuited, and current comes on 14, 15, 16. It will be seen that there is a total of twelve terminals on the motor.

Regarding the bar winding of the stator, both windings are laid with bars, and each system employs four bars in each slot, using a tube of compressed mica on each bar. Half-open slots are used in order to introduce the lathe-wound coils. Stator laminated iron is held, as usual, between end rings, but as the motor goes as low as 3.6 meters a second periphery speed there is no ventilation to be had by this means, so that no air holes are provided in the stator mass. Maximum periphery speed is about 10.8 meters a second. The section view of the motor, Fig. 5, makes the different parts clearly visible. The laminated rotor is of the usual design and has a squirrel-cage winding, using copper bars laid in 528 slots. The ends of bars are forced into a copper ring previously perforated to receive them, then brazed with silver on the most approved method, and this gives a strong and very reliable construction for the rotor, which avoids all accidents.

One of the original features of the Oerlikon method is the mounting of the transformer and starter box in very compact shape with the rotor, as will be observed, and by this design there are only very short connection wires to the motor. Other views show the transformer and the starter as contained in the oil box, the cover being made in two parts. One half covers the transformer, while the whole of the motor-starter is suspended from the second cover so that it can be readily lifted out. Connections between starter and transformer are made by binding posts mounted on the two covers, which are joined across by small copper strips.

The motor-starter, Fig. 4, is made up of three cast iron drums of controller type, which work together the same movement by the use of gearing at the to and the hand-wheel thus turns all three drums at one. One drum corresponds to each phase of current, th avoiding crossings and connections. The iron drum

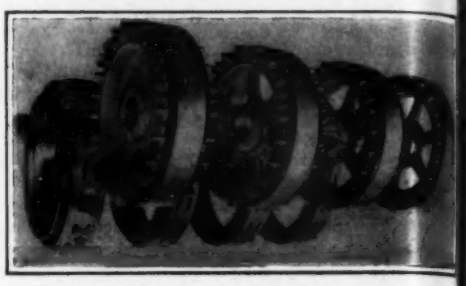


Fig. 2.—Stators and rotors of the new motor.

are mounted on square shafts from which they are ins lated, and carry screwed copper contact plates. Fin contacts for each drum are carried on a wood strip, a the current break comes upon auxiliary contact piec which are easy to replace, while the main pieces a undisturbed.

The weight of the present motor, including founda tion plate, but without bearings or shaft which proper belong to the pump, is about eight tons; weight transformer and starter outfit, 2.2 tons.

In the design of the present motors, it will be see that the Oerlikon Works has opened up a new field fo the application of three-phase motors, which is quite a important one, and it is thus shown to be possible t construct motors which work economically and wi speed varying from 1 to 3, and at the slow speed wi good flywheel effect, such as is needed for mini pump use.

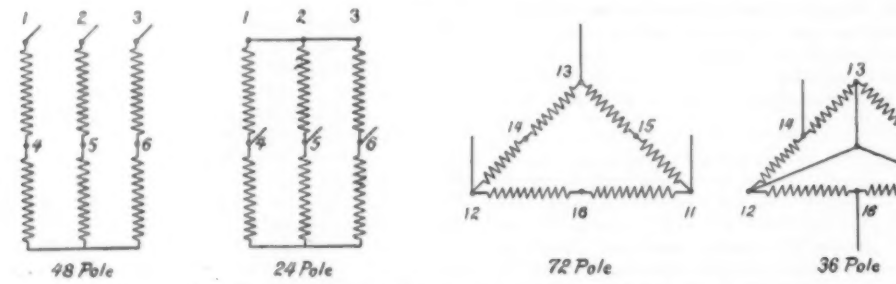


Fig. 3.—Diagram of the various connections in the Oerlikon variable speed electric motor.

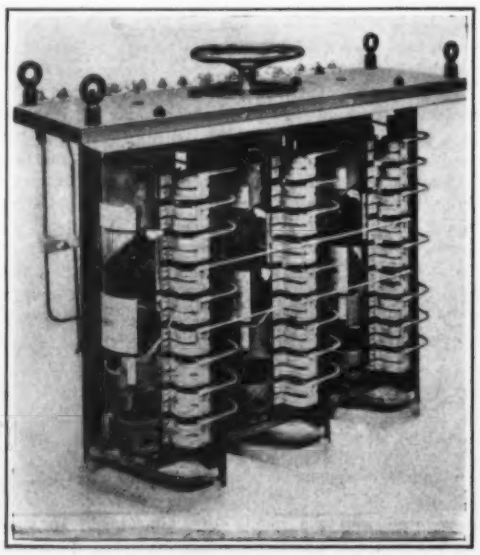


Fig. 4.—Interior view of controller and starter.

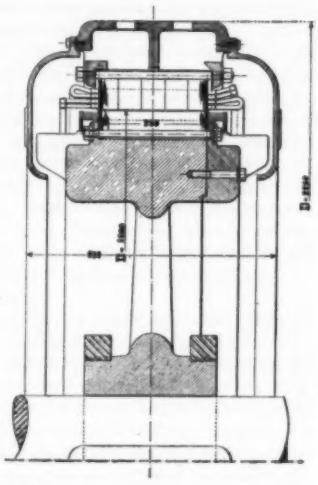


Fig. 5.—Transverse section of Oerlikon rotor.

A New Way to Make Steel Joints

A NEW material called "amalgaline has been intro duced in England for making joints between lead su faces, and it is said to have been widely adopted b shipbuilders in Scotland and the north of England. it is useful in flanging and the seaming of lead used lining refrigerating chambers. The system is not co fined to use on small pipes, but is used in an ordinar way on pipes varying in bore from 3 inches to 9 inche Like lead burning, it is an autogenous process, bu instead of using an intense local heat the fusion i effected by the action of the amalgaline on the surface it is in contact with, forming an amalgamation betwee the lead of the flange and the lead pipe. The materia used is in the form of a metallic ribbon of 0.002 inc in thickness, practically a pure metal, which, whe placed between the surfaces of lead and subjected t heat, fuses at a temperature of 160 degrees—lower tha the actual fusing point of lead—and in fusing it cause the lead surfaces to run together at a lower melting point than that of the body of the lead. This running together has an autogenous effect, and by intermole ular absorption the minute particles of amalgaline ar dissipated into the body of the lead, which, by reaso of the absorption, becomes stronger at the junction tha elsewhere.

New Experiments with Liquid Air*

At the temperatures of liquid air (—182 to —194 deg. Cent. according to the proportion of oxygen) organic tissues become more brittle than glass. "Burns" caused by liquid air do not heal in months, and a finger that

Fig. 2.—A glass fork cooled by liquid air and exposed to the atmosphere becomes covered with ice, smooth on the right fork, but brush-like on the left, which has been electrified by rubbing.

has been immersed in the liquid for a sufficient time can be broken as easily as a window pane. Nevertheless it has been proved by recent experiments that highly organized animals live in liquid air.

A goldfish immersed in liquid air was instantly frozen, but it revived and swam vigorously a few seconds after it had been replaced in water (Fig. 1). It showed the effect of its experience in the intense red color of its gills, but it probably suffered little pain, for liquid air is used as a local anæsthetic in surgery.

Fig. 1.—Goldfish frozen stiff by immersion in liquid air, quickly resumes its activity when replaced in water.

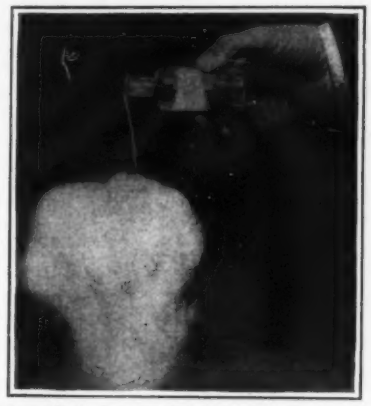


Fig. 3.—Alcohol poured into liquid air overflows the vessel as an avalanche of snow.

The behavior of electrified glass rods at the temperature of liquid air is very interesting.

Fig. 2 shows a glass fork with its right prong coated smoothly with ice, while the left prong is covered with little icicles, arranged radially. The left prong had been electrified by rubbing it with a piece of leather, and the brush-like form of the coating of ice is due to repulsion of the congealing particles of aqueous vapor condensed from the atmosphere.

Fig. 4.—A leaden bell rings clearly after immersion in liquid air.

Fig. 3 illustrates the freezing of alcohol by means of liquid air. Wine, beer, and distilled liquors are instantly frozen solid when they are poured into liquid air. But the freezing of alcohol, which occurs at —110 deg. Cent., liberates so much heat that the liquid air is thrown into violent ebullition, and the congealing alcohol overflows the vessel as a little avalanche of snow.

Almost all liquids are solidified and almost all solids are hardened and stiffened by immersion in liquid air. India rubber tubes become as brittle as glass. A leaden bell, which produces no musical tone at ordinary temperatures, becomes as hard as steel and rings as clearly as a bell made of bell metal (Fig. 4).

* Translated from *Umschau*.

Approximate Measurement of Textile Fibers

By N. A. Cobb

This note is hardly the place for the demonstration of the following theorem. However, it is readily capable of demonstration, and the reader with a mathematical turn of mind will at once perceive the line of proof.

Theorem.—If an infinite series, consisting of straight parallel linear elements of every possible length, each element arranged perpendicularly to and symmetrically on a given straight line, be bisected along that line and the two half-series thus produced be placed with the

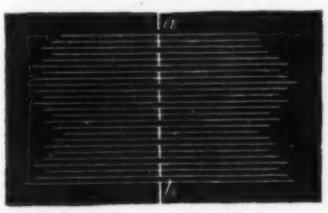


Fig. 1.—Straight elements varying in length within prescribed limits, arranged symmetrically with reference to a given straight line, *a b*, in accordance with theorem.

former outer edges adjacent; then, if the elements of one of the half-series be systematically rearranged, its longest element matched to the shortest of the other half-series and its next longest to the next shortest of the other half-series, and so on, a new parallel-sided series will be produced, each of whose elements has a length equal to the mean length of the elements of the original series.

If the theorem be changed so that the elements are limited to vary in length within prescribed limits, then in this modified theorem the line of demonstration as well as the final result is the same.

If the number of elements is limited, say, for example, to a few thousand, the result becomes approximate; and if the elements, instead of having their middle points on the given straight line, are arranged so that their middle points fall at random on either side of the given straight line a distance less than half the length of the shortest element, then the reconstructed series will have a width approximately equal to the mean length of the original elements; for it will always be possible to pair the elements whose middle points fall to the right with those whose middle points fall to the left in such a way, the long with the short, as to secure

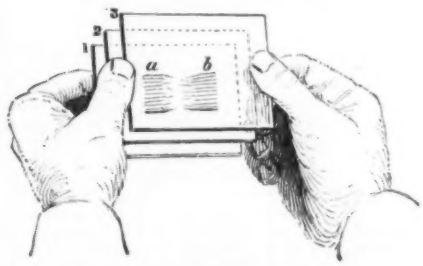


Fig. 3.—Application of the theorems to the measurement of textile fibers in mass; for instance, a "pull" of cotton fibers. The pull consisting of about 2,000 fibers, is cut in two transversely, near the middle, with clean, sharp shears. One half of the pull *a* is placed between thin glass plates, 1 and 2 (lantern plate covers). The other half is placed between the glass plates 2 and 3; 1 and 2 are pressed firmly together with the left hand, as shown, while 3 is held loosely with only its left hand edge in contact with 2 and resting against the left thumb, its right hand edge being lifted so as to enable the operator to move the fibers *b* back and forth over the fibers *a* by friction. Or the fibers *b* may be moved back and forth in any one of the several different ways. Thus *b* may be moved back and forth by applying the edge of 3 to the cut ends of the fibers. Care must be exercised not to disturb the parallelism of the fibers.

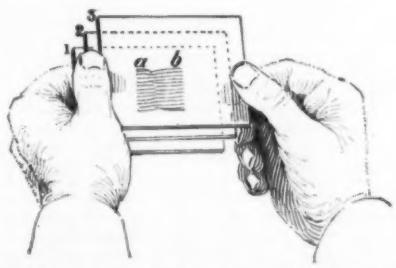


Fig. 4.—The halves of the "pull" shown in Fig. 3 matched ready for measurement. The halves are adjusted against a strong transmitted light; *b* is so adjusted over *a* that the fiber masses present the same shade from end to end. When so adjusted, the three glass plates are held in the left hand, while the measuring scale is applied with the right hand. This simple optical method is found to approximate the conditions of the theorems. The width of the series as arranged in Fig. 4 represents the mean length of the fibers minus the "fly-back." This latter, about one millimeter in twenty-five for well conditioned cotton fibers, has to be added. The results are accurate to the fraction of a millimeter. The method is definite, readily learned, and easily applied.

the result stated in the theorem approximately, the degree of approximation depending on the number of the original elements and the uniformity of their increments in length when arranged in the order of their magnitude.

It has been ascertained by comparison with the results of my accurate method of measuring the length of fine crooked fibers, a description of which has already been published, that if a series of fibers be arranged in a manner similar to that described in the theorems, the mean length of the fibers can be measured approximately, if proper allowance be made for the "fly-back,"

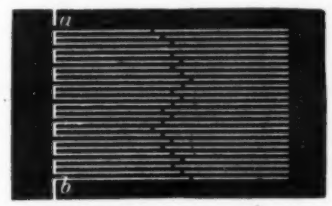


Fig. 2.—Series shown in Fig. 1 bisected, and its left half transposed and turned over. For the sake of simplicity, in Fig. 1 the elements are so assorted that in Fig. 2 they match without rearrangement. The width of the second series (Fig. 2) equals the mean length of the original elements.

or apparent shortening of the fibers, due to their elasticity. The method is more definite and more accurate than that in common use by cotton experts.

Manufacturing Conditions in Germany

Although the great metal manufacturing establishments of Germany have lost their export trade, they are still being operated to their limit in turning out war and railway material on government orders, being obliged to work night and day. Many of these works have lost nearly one third of their men to the army, but several are endeavoring to supply the deficiency by taking on men from other industries that are suffering from depression.

The question of employing prisoners of war, especially in mines, has also been raised, as it is of paramount importance to maintain a continued supply of coal. The coal mines in the Ruhr district must now serve a much larger area than before, owing to the cessation of the imports of English coal. Many mines have lost about 40 per cent of their men by mobilization, and the supply of coal is diminished by about one half.

Design of Floats for Hydro-Aeroplanes—II*

Giving the Results of Tank Experiments with Various Models

By G. H. Millar, B.A.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2028, Page 320, November 14, 1914

Considering the form of the bow, it will be seen that type 2 is really an intermediate form between types 1 and 3. The curves of resistance show that type 3 is a good deal the better. With these flaring bows the "mud-guards" shown are essential. The first model made of type 2 was run without "mud-guards" and with no air-holes to the step. The result was that a filmy wave ran up the side of the model, no air could get to the step, and the resulting suction held the float down so firmly that it never rose at all. The "mud-guards" throw the water clear of the sides, and at the same time derive a large lift from it.

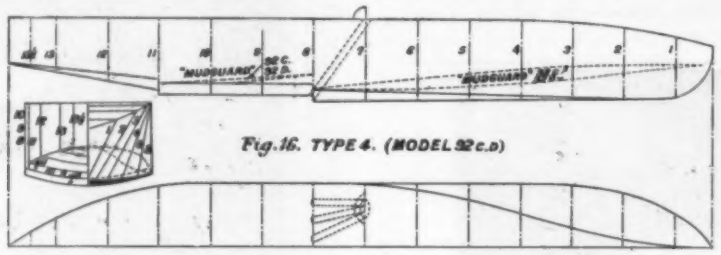


Fig. 16. TYPE 4. (MODEL 92c.D)

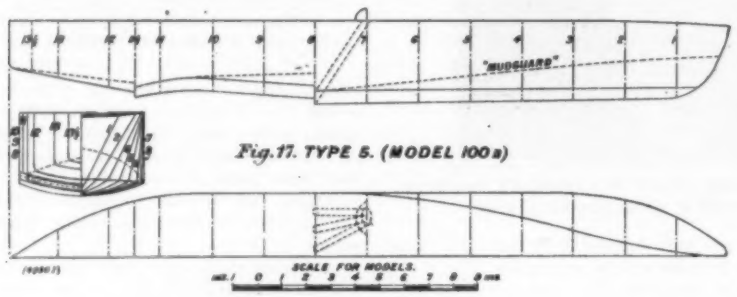


Fig. 17. TYPE 5. (MODEL 100a)

The type 3 float, although quite satisfactory from a resistance point of view, was found to induce an excessive positive trimming moment at about the "hump" speed, which would naturally tend to tilt the machine at this speed until the tails of the floats were in the water. This was confirmed by tests with an actual machine fitted with such floats. To obviate this trouble a series of experiments were made with models having two planing surfaces, of which that shown in Fig. 17 (type 5) proved the most successful. It will be noticed that the shape of the after termination has been altered from a pointed one to one with a vertical stern-post, and its chines rounded off to reduce eddy-making at the low speeds during which it is in the water. The flat bottom of type 3 has now been replaced by a cambered one of circular section. This is much stronger and less liable to slam, and the loss of efficiency is negligible. It is, however, important, if using a cambered bottom, to make the camber constant or decreasing from forward to aft. A surface in which it increases going aft will be extremely inefficient.

The shape of the bow has been altered slightly to increase the stability at small angles, and the "mud-guards" have been straightened out and lifted at their fore ends for the same reason. Although the flaring bow makes for stability in the same way as the overhang of type 1 float, it must be remembered that it also will throw up the water as soon as the fore ends of the "mud-guards" are submerged. As the resistance term tends to reduce the righting moment, the upper water-lines should be kept reasonably fine.

The results obtained from the six models illustrated are shown in Figs. 18 to 27. The model denoted by 92*e* consists of the forebody of 92*c* with the middle body and tail of 100*b* while model 100 differs from 100*b* in having the hollow of the after plane filled in.

The first point of interest is the comparison of the curves of "linear rise" with those of resistance. The "linear rise" of a float denotes the vertical height of the float above the statical position under full load, its angle being maintained constant. The study of a large number of such curves of rise shows that normally there is a speed at which the rate of rise becomes rapid, and this speed is always just below the "hump" speed on the resistance curve. If there is a good deal of steady rise before this speed is reached, the corresponding part of the resistance curve will be lowered, and the "hump" will occur at a rather later speed. This is particularly noticeable in the case of model 92*e*, where the second planing surface is 7 deg. steeper than the first, and has therefore a greater efficiency than if parallel to it. Model 98 (type 1) has quite a different curve—a long, steady rise—and it will be noticed that the resistance curve has two humps, the space between them covering about the middle third of the rise. It was found that in every case where a float rose evenly and gradually the hump on the resistance curve was flat and spread out, or there were two humps with a hollow in between. The peaky curves usually show traces of a second hump some way down the slope. In the case of model 98 it is practically certain that the second hump is due to the suction of the waves against the sides near the stern (see Fig. 10), and it will be noticed that there is an exactly corresponding increase of the positive moment owing to this cause. When these side waves leave the stern the resistance and moment curves both come down.

FIGS. 18, 19, 20 IN MODEL UNITS (ONE FLOAT)

Fig. 18.

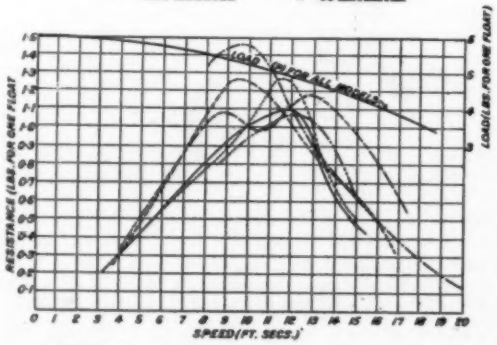


Fig. 19.

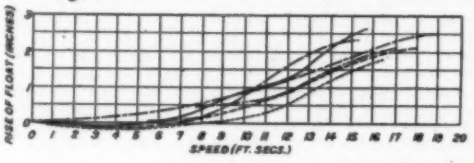
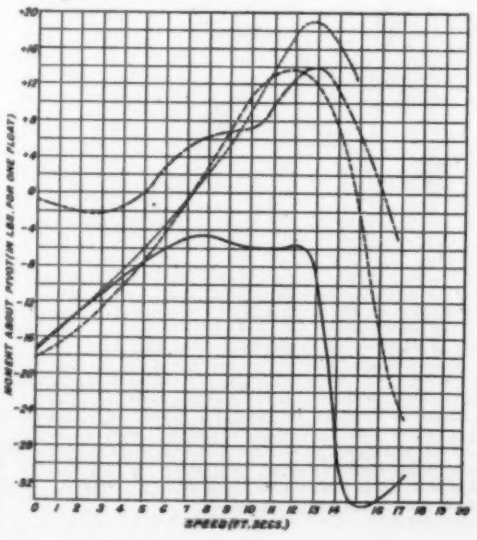


Fig. 20.



The resistance and moment curves both come down.

Clinging side waves of this type do actually occur against the sides of the tail in the case of the other models, but only at a much lower speed. They pass astern at a speed of about 9 foot-seconds for the model. It may be said generally that the drop after the hump on the resistance curve shows that there is no longer any appreciable resistance to the float rising in the water. Provided that the bottom is of a suitable hydroplane type, it will always give a good lift even at speeds well below the "hump," and such resistance is due either to the suction of waves against the sides of the float, or to suction on the bottom caused by an unsuitable shape or an insufficient supply of air to the step or steps. Experiments with stepped models, with and without air-holes, always show that the model without air-holes rises later, and, consequently, has a later and bigger "hump" on the resistance curve. In the double-stepped models air-holes were only fitted to the forward step, it being impracticable to fit them to the second step owing to the after weight pocket being over it. It is highly probable that an improvement would result from fitting them, and that the later "hump" on the curve of 92*e* (as compared with 92*c*) is due to greater suction aft of the second step, its greater angle deflecting the water more downward, and so leaving a bigger vacuum to be filled.

Any form of float in which the waves tend to cling to the sides needs "mud-guards" of some kind to throw the water clear; and, to render them really effective, they should be of a fair breadth. With a float, whose sides are vertical, a sharp chine at the junction of the sides and bottom without any projecting plane, will be fairly effective. The experiments with double-step floats showed the desirability of fitting "mud-guards" to the second step as well as to the first. The angle of the "mud-guards" should not be too great, or they will have a high resistance. On the other hand, their forward ends must be well up to give safety at small angles, and the almost straight ones of model 100*b* seem to be the most suitable.

In racing hydroplane boats the "mud-guards" are always made convex downwards, and they were so fitted in 92*d*, which only differed in this respect from 92*c*. They then had a much smaller effective angle, and gave a smaller lift at all speeds below the "hump," but also had a smaller resistance. The float rose very little till the "hump" speed was reached. It will be seen that in spite of this the whole resistance is greatly reduced at moderate speeds, but the "hump" is a good deal later and of a considerable height, owing to the waves tending to cling to the sides aft of the second step. On the whole, therefore, little is gained from this shape of "mud-guard," while the stability at small angles is decreased. But in the case of multiple-step floats, where the "mud-guards" are of a restricted length, it may be useful to curve them in this way, so as to keep their forward ends up with a smaller effective angle.

As was mentioned above, floats with two planing surfaces offer advantages in respect of the trimming moments involved. The line joining the steps should be at about 5½ deg. to the mean forward planing surface, and to render the second surface effective it should have a greater angle than the first. This is shown very clearly by the remarkable difference in the moment diagrams for models 92*c* and 92*e*. If, however, the distance between the steps is increased, the angle of the second step should be correspondingly decreased. This is obvious from a consideration of Fig. 8. The second step also decreases

* Paper read at the joint meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle-on-Tyne. Reproduced from *Engineering*.

the resistance considerably. All experiments showed that where a double-step float at a planing speed could be made to run either on the forward planes alone, the back plane alone, or both planes, by slightly altering its angle, the smallest resistance was obtained when running on both planes. This is to be expected, as we have two planes immersed of a larger aspect ratio in place of one plane of a smaller aspect ratio.

It is not, of course, in any way a necessity to fit the overhanging tail shown on the models. If desired, the second step may be at the after end of the float, and the upper surface sloped down to it, so that the float terminates in a horizontal edge.

There seems no reason to increase the number of planing surfaces beyond two. With a greater number it will be difficult to divide the work equally between them, while the length of entrance will be decreased, and the "mud-guards" if any, will need to be steeper. Each additional step means more eddy-making, and therefore greater resistance at low speeds and greater constructional difficulties.

The importance of the horizontal position of the centre of gravity of the whole machine has been referred to above. The question of longitudinal trim may be attacked in three ways:—

1. The designer may attempt to design his floats so that at all speeds they shall run at any reasonable angle without introducing large trimming moments, either positive or negative. It is doubtful if this is at all feasible.

2. He may attempt to design a float which shall run steadily at nearly the same angle at all speeds, and shall resist any attempt to make its angle larger or smaller.

3. He may, by the judicious use of the tail float, produce a machine which will start off at a large angle and gradually come down to a small angle at high speeds, with or without the use of the elevator.

In the author's opinion, Condition 2 is the most desirable one to aim at. It is obvious that the machine will get off much more quickly if it is running throughout at its most effective angle.

A float of type 1 has a tendency to run at a large angle at moderate speeds and a small one at high speeds; and, although at a high speed the angle can be readily increased by the use of the elevator, there will be a sudden change of moment when the machine leaves the water, which may cause the tail of the machine to come down and hit the water.

Condition 2 seems to be most easily satisfied by a double-plane float approximating to type 5. Here the designer has a number of variables to deal with. He can fix the position of the *C B*. at rest by shortening or lengthening the tail of the float, and can alter the position of either or both steps. It will be seen that for float 92*c* the maximum positive moment occurs at a low speed—about 6½ ft.-seconds for the model, equivalent to 15 ft.-seconds for the full-size machine. Hence, the machine can start off at a large angle with a considerable load on the tail-float, and can, therefore, maneuver comfortably on the water at very slow speeds, while taking up its most efficient angle at a moderate speed. It will be noticed that the moment diagrams show a large negative moment at high speeds. But at these speeds a reduction of 1 deg. to 2 deg. in the running angle will change this to a large positive moment, so that the machine will run quite steadily at an intermediate angle. The natural running angle can be varied by varying the relative depths of the points of the two steps. The positive moment at any speed can be increased to any desired extent by increasing $g - i$. *e.*, by placing the floats farther forward.

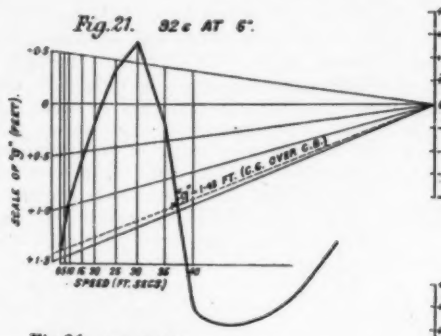
It must be remembered that the experimental results only hold for smooth water. The effect of rough water will be to increase the resistance considerably, and hence to reduce the positive moments.

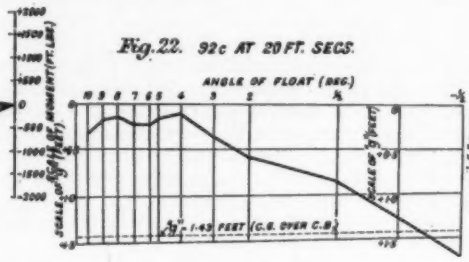
A point that must receive careful consideration is the possibility of the machine coming down at too high a speed and too small an angle through the pilot misjudging his distance from the water. Unless the floats are stable at small angles this is very likely to cause the machine to turn a somersault. The same requirement holds for running on rough water if the floats are to ride over the waves, and not plough through them.

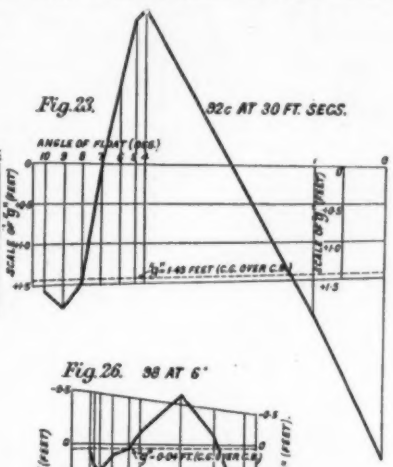
In conclusion[4], the author wishes to acknowledge his great indebtedness to Mr. G. S. Baker, at whose suggestion this paper was written, and in conjunction with whom the whole of the exprimental work was done, and to Mr. J. L. Kent, who assisted in this work. Also to the Advisory Committee for Aeronautics for their kind permission to make use of the experimenal work done for them, and to reproduce a number of diagrams from the Official Reports.

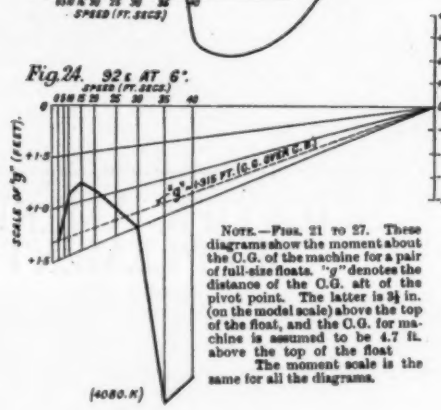
The complete experimental results will be found in the following reports by Mr. G. S. Baker and the author, which are already published or in the Press:—Report No. 70, November, 1912; Report No. 98, November, 1913; Report No. 99, March, 1914.

Fig. 21–27. IN MACHINE UNITS (TWO FLOATS.)



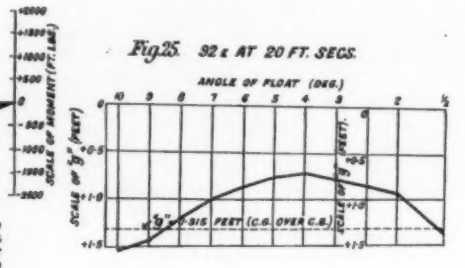


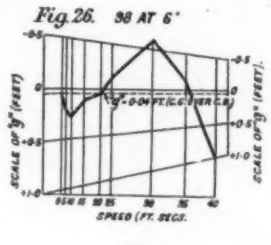


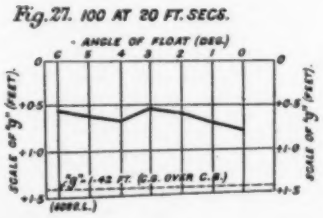


NOTE.—FIGS. 21 TO 27. These diagrams show the moment about the C.G. of the machine for a pair of full-size floats. "*y*" denotes the distance of the C.G. aft of the pivot point. The latter is 3½ in. (on the model scale) above the top of the float, and the C.G. for machine is assumed to be 4.7 ft. above the top of the float

The moment scale is the same for all the diagrams.







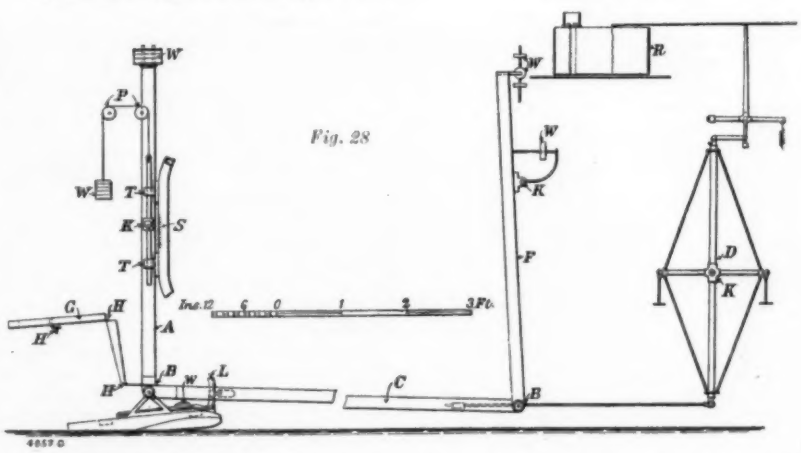


Fig. 28

[4] Since writing this paper the author has come across a paper giving the results of some tests with models of flying-boat hulls made in the tank at Washington ("Hydomechanic Experiments with Flying-Boat Hulls," by H. C. Richardson, Naval Constructor, United States Navy—Smithsonian Miscs. Collections, vol. 62, No. 2, April 20th, 1914). The results obtained seem to be in general agreement with those here described, but the information given is rather scanty, and the greater part of the paper is devoted to submerged experiments to determine the air resistance. (At the National Physical Laboratory this is determined more directly by means of the wind channel.) No attempt was made to measure the trimming moments when running on the surface.

APPENDIX.

Methods Adopted for Testing Hydro-Aeroplane Floats in the William Froude National Tank.

1. *Apparatus.*—The apparatus used for testing the floats is shown in Fig. 28. The floats are made with a flat upper surface which is parallel to the forward mean planing surface, and are screwed on to an aluminium carrier, at the forward end of which is a graduated arc *L*. The carrier is attached by ball-bearings *B* on a transverse horizontal axis to a vertical frame or gate *A* and a horizontal gate *C*. The forward end of the gate *C* is attached by other ball-bearings to the vertical gate *F*, and by a light-balanced steel rod to the dynamometer *D*. The forward frame *F* is supported on knife edges on fixed bearings and has balance weights *W*, *W*. The after frame *A* is also supported on knife edges, but the seatings are not fixed, but are suspended in vertical slides by light wires which pass over ball-bearing pulleys *P*, *P*, and carry weights on their other ends. Pointers are attached to the knife-edge seatings, and their height can be read off on vertical scales *S*, *S*. The frame *A* has balance-weights at the top, which are adjustable in amount, and two sliding weights on the upper arms, and a horizontally sliding weight (not shown on diagram) to balance the frame. *G* is a three-hinged frame to prevent lateral movement of the float. A stop can be clamped at any point on the arc *L*, which engages with adjustable jaws attached to the frame *C*. These jaws are opened just enough to allow the float to rock through a small angle (about ¼ deg. each side or the mean).

The method of running is as follows: The weights of all parts of the apparatus are known, and the forward frame is first balanced about *K*, a weight equal to that of the towing-rod and the proper share of the weight of *C* being suspended from *B*. The after frame is then balanced with everything in place, and the float just clear of the water and balanced about the axis *B*, so that there is no pressure on the stop. In any given run the correct load "*P*" is applied to the float by attaching suitable weights to the suspending wires, and the resistance (*R*) is measured by the dynamometer *D*. During the run, and before taking the resistance record, the float is accurately balanced about the pivot point *B* by means of movable weights on it, and a sliding weight on the float-carrier, so as to get the stop on the arc just floating between the jaws. From the position of the weights in conjunction with their position when the model is bal-

anced in air at the same angle we deduce the moment (M) of the water forces about the pivot.

Let S be the dynamometer record (in pounds).

W_1 the weights of frame F acting at a height g_1 above K.

W_2 the weight of frame A acting at a height g_2 above K.

a_1 the radius of K B for forward frame F.

a_2 the radius K B for after frame A.

X the load on the wires carrying after knife-edges.

w_1, w_2 the components of the weight of C at the forward and after bearings.

θ_1, θ_2 the inclinations of frames F and A to the vertical.

ϕ the inclinations of frame C to the horizontal.

W the weight of float, carrier, and sliding weights and (f, g) the co-ordinates of their center of gravity relative to the pivot.

P, R the vertical and horizontal components of reaction of water on floats, and (p, r) the co-ordinates of the center of pressure relative to the pivot.

Then it can be shown that—

$$S = \left(w_1 - W_1\frac{g_1}{a_1}\right)\theta_1 + \frac{1+\theta_1\tan\phi}{1+\theta_2\tan\phi}\left[R + \left(-P + W + w_2 - W_2\frac{g_2}{a_2}\right)\theta_2\right] \quad (1)$$

and

$$P = (W + W_2 + w_2 - X) + \frac{\tan\phi}{1+\theta_1\tan\phi}\left\{\left(w_1 - W_1\frac{g_1}{a_1}\right)\theta_1 - S\right\} \quad (2)$$

$$P\,p - R\,r - W\,f = 0 \quad (3)$$

By our method of balancing we make—

$$w_1 - W_1\frac{g_1}{a_1} = 0$$

and

$$W + w_2 - W_2\frac{g_2}{a_2} = 0$$

Also $\theta_1 = \theta_2$ approximately, and both θ_2 and ϕ are small.

Hence equations (1) and (2) reduce to

$$P = (W + W_2 + w_2 - X) - S\tan\phi.$$

$$R = S + P\theta_2.$$

The angle ϕ is obtained from the vertical height scale, and θ_2 from the position of the resistance record on the drum. The air resistance of the apparatus at different speeds is obtained by experiment and deducted.

2. *Reduction of Results.*—No correction is made for surface friction in reducing the results for model to full-size float. The models are on a comparatively large scale, while they are actually so small that the fractional co-efficient is rather doubtful. Moreover, the amount of wetted surface varies greatly with the speed, and the speeds are so high for the length of float that the skin friction resistance is a comparatively small part of the whole. The error involved in neglecting the correction is only of the order of 3 to 4 per cent., and is always on the safe side.

This being the case, if the ratio $\frac{\text{model}}{\text{full-size float}} = \frac{1}{\lambda}$, then if P R are forces in pounds for model at a speed of v foot-seconds, and M is moment in inch-pounds for model at the same speed, the corresponding forces and moments for the full-size floats at a speed of $v\,\lambda\,\frac{1}{2}$ foot-seconds are

$P\,\lambda^3$ lb., $R\,\lambda^3$ lb., $\frac{M\,\lambda^4}{12}$ ft.-lb. For the instance given above $\lambda = 5.67$, $\lambda\,\frac{1}{2} = 2.381$, $\lambda^3 = 182.28$ $\frac{\lambda^4}{12} = 86.13$.

Radio-activity and Atomic Numbers

Let Th_T, Ra_T, Ac_T be the periods of half-change of corresponding members of the thorium, radium, and actinium family respectively, M the atomic number, M(Pb) that of the lead-group, and c a constant ($=4.5$); then for all substances emitting α rays:

$$Th_T = \sqrt{Ra_T \,.\, Ac_T / c^{M-M(Pb)}}$$

For analogous β-radiators $Ra_T \,.\, Ac_T/Th^2_T$, though not unity for group B I V. is >1 for B III., and <1 for B V. (the only three groups in which comparable values are known).

The only exception here, as in all similar relations, is thorium-X (or actinium-X). For radiothorium, where a few months as well as two years are given for the period of half-change, the formula gives the first value. Of course, very accurate results cannot be expected from values like 2 minutes, 3 minutes, 0.002 second, etc., but the differences are nowhere greater than what from this lack of precision must be expected.

	Periods of Half-change.	Calculated.	Experimental.
Radiothorium	$\sqrt{365 \times 10^9 \times 19.5/4.5^9}$	d = 65 days	A few months
Thorium emanation	$\sqrt{3.86 \times 86400 \times 3.9/4.5^4}$	s = 56.4 seconds	53 seconds
Thorium A	$\sqrt{180 \times 0.002/4.5^2}$	s = 0.134 second	0.14 second
Thorium C_1^a	$\sqrt{45 \times 24 \times 0.0333/4.5}$	h = 2.83 hours	2.87 hours
Ionium	$4.5^3 \times 65^2/19.5$	$d = 10^5$ years	10^5 years
Radium emanation	$4.5^4 \times 53^2/3.9$	s = 3.42 days	3.86 days
Radium A	$4.5^2 \times 0.14^2/0.002$	s = 3.31 minutes	3 minutes
Radium C_1^a	$4.5 \times 2.87^2/0.0333$	h = 46.4 days	45 days
Radio-actinium	$4.5^3 \times 65^2/365 \times 10^3$	d = 19.5 days	19.5 days
Actinium emanation	$4.5^4 \times 53^2/3.84 \times 86400$	s = 3.5 seconds	3.9 seconds
Actinium A	$4.5^2 \times 0.14^2/180$	s = 0.0022 second	0.002 second
Actinium C_2	$4.5^2 \times 10^{-12}/10^{-4}$	$s = 2.10^{-12}$ seconds	?
Actinium C_1^a	$4.5 \times 2.87^2/45 \times 24$	m = 2.03 minutes	2 minutes

—*A. van den Broek, in Nature.*

Fuel Alcohols

By Aug. Zimmermann

The great difficulties of discussing ethylic alcohol as a fuel are enhanced by the confusing terms used by some of your contributors. They are applying the word alcohol and spirit to several substances, nor do they differentiate between a proof and a liquid gallon when speaking of ethylic alcohol, by which means much misleading construction is being built up. Let us, therefore, agree in these discussions upon terms.

1. Ethylic alcohol, synonym, pure spirit, is obtained by fermentation of saccharine substances. This is quoted in this country in the market at per proof gallon, but delivered and invoiced in the form of liquid gallons, adding about two-thirds of the cost of the proof gallon.

2. Methylic alcohol, synonym, wood spirit, is obtained by the refractory distillation of wood, and is quoted and sold per liquid gallon only.

When Nos. 1 and 2 are mixed in certain proportions required by the Industrial Spirit Act, we obtain

3. Methylated alcohol or methylated spirit, which is also sold at so much per liquid gallon.

Our main object is, as I understand, and as I have myself always advocated, to arrive at a supply of ethylic alcohol, preferably made in this country from substances that are always with us, but if, at 1¾d per gallon this is an impossibility under any condition.

To make this clear I point out that the quantities of ethylic alcohol obtained from—

1 ton of wood waste or sawdust is 30-35 proof galls.

1 ton of molasses 50 per cent. sugar is 90-100 proof galls.

1 ton of pure starch is 225 proof galls.

The relative cost of these products is:

Waste wood about 15s per ton.

Molasses about £3 10s per ton.

Pure starch about £7 10s to £8 per ton

In working wood you obtain valuable by-products sufficient to pay for the working, while the treatment of starch is the more expensive process.

A simple calculation will then show that, considering the manufacturing expense, the proof gallon of ethylic alcohol cannot be produced at less than 1s per proof gallon, or about 1s 9d or 1s 8d per liquid gallon, and the methylated spirit would not cost much less than 2s per liquid gallon.

These are the only practical figures which should come under consideration, and they are, moreover, the utmost limits making an industry possible.

Considering the raw materials, I would mention that wood waste we have always with us in this country, and sufficient in ordinary times to produce about 3,000,000 liquid gallons of ethylic alcohol per annum, while molasses and cereals we have to import, and we cannot depend upon them in case of war, when more especially all cereals will be required for food purposes.

In considering the value of alcohol in modern warfare I remind you that the Japanese could never have carried on their war with Russia if it had not been for the supply of Russian spirit which they largely accumulated before declaring war on that country, and which, during the progress of that war, they were constantly importing from Hamburg and Liverpool. This is only to show what an important role the supply of alcohol plays nowadays in the modern requirements of a country, both for fuel and defensive purposes.—*The Daily Telegraph*, London.

Light in Gas-Charged Rooms

It has been shown by experiment that high candle-power electric lamps are dangerous in rooms where the atmosphere is charged with inflammable gas, for if the bulb is broken an explosion is almost certain to occur. Tungsten lamps ignited the gas in 25 to 85 per cent of the tests. The 8 candle-power 220-volt carbon incandescent lamp, however, caused only one ignition in twenty tests, and this was a test made by breaking the tip from the bulb and allowing the gaseous mixture to enter in a small stream which did not break the filament. For additional safety, it is recommended that wiring for electric light where gas is present should be installed in iron pipe conduits. If switches are used where gas is liable to be present, the switch boxes should be made gas-tight. As an additional safeguard the incandescent bulbs may have heavy glass outer globes and metallic shields outside.

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